JT520

Operator's Manual

CE

CMW®

Issue 1.1

053-1219

Overview

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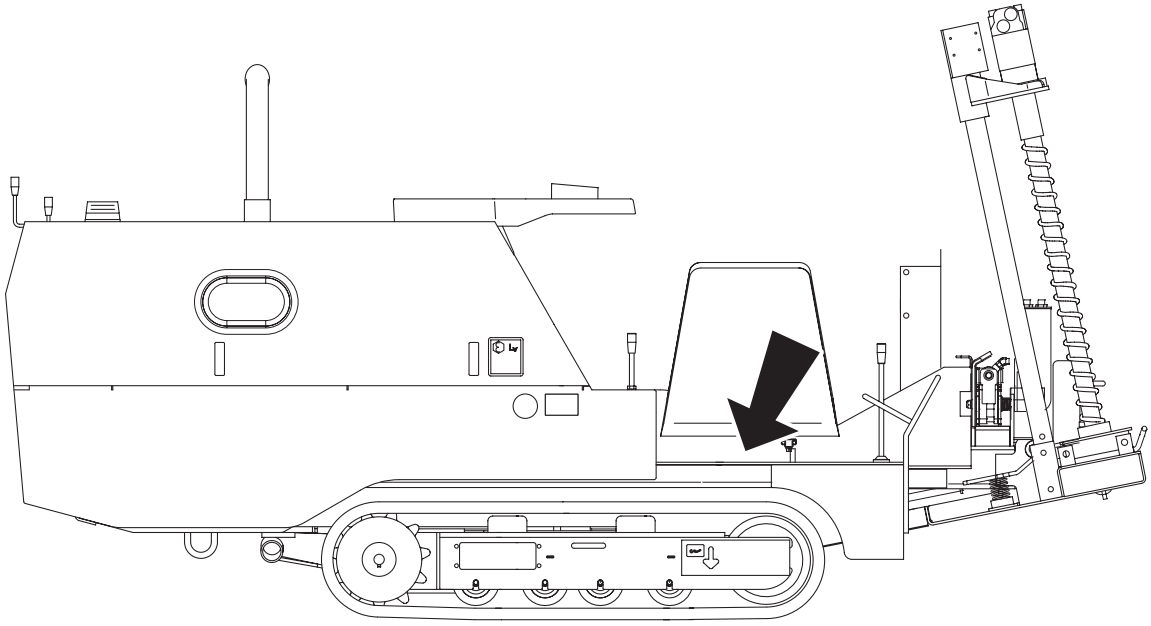
Serial Number Location

Record serial numbers and date of purchase in spaces provided. Drilling unit serial number is located as shown.



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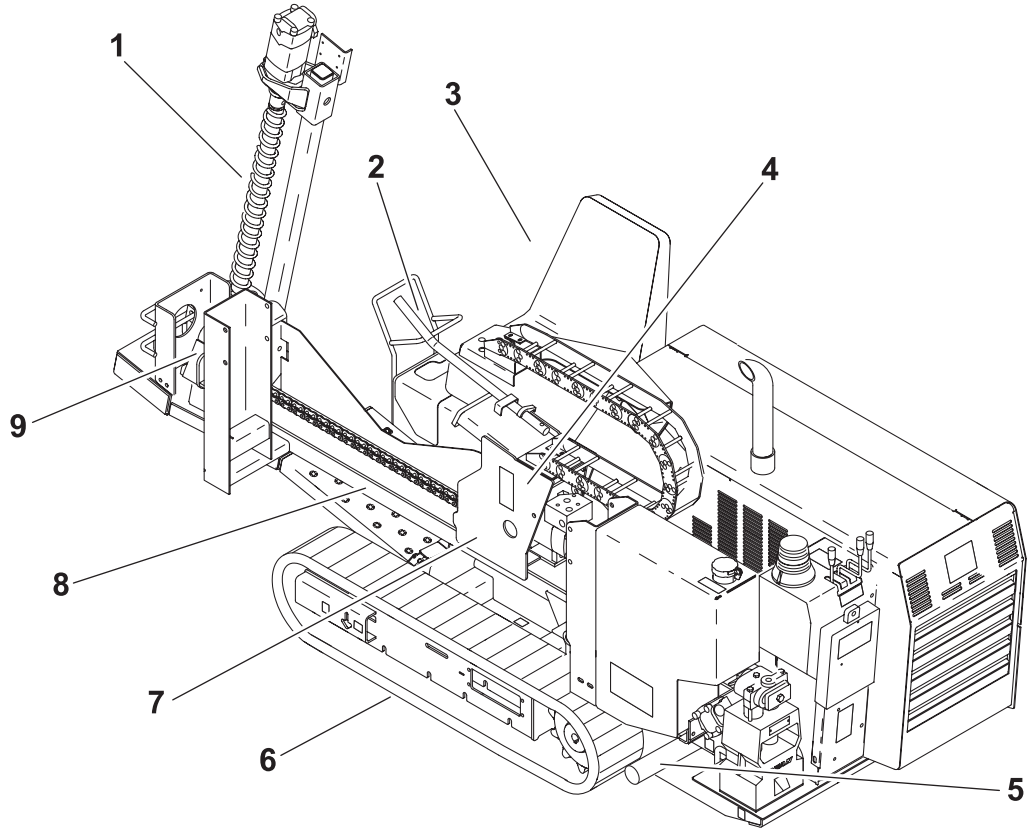
Item	
date of manufacture	
date of purchase	
drilling unit serial number	
trailer serial number	
engine serial number	

Intended Use

The JT520 is a self-contained horizontal directional drilling unit designed to install buried cable and pipe at distances to 150' (45.7 m) depending on soil conditions and is intended for operation in ambient temperatures from 0° to 115°F (-18° to 46°C). Use in any other way is considered contrary to the intended use.

The JT520 can be used with Ditch Witch drilling fluid units and Ditch Witch locating equipment. It should be operated, serviced, and repaired only by persons familiar with its particular characteristics and acquainted with the relevant safety procedures.

Unit Components



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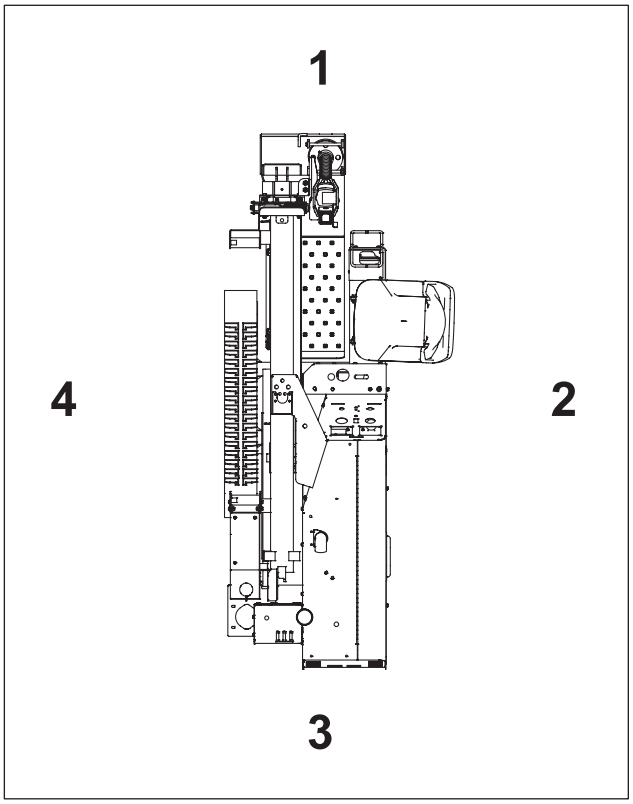
1. Anchoring system
2. Auxiliary wrench
3. Operator's station
4. Carriage
5. Stabilizer
6. Tracks
7. Spindle
8. Drill frame
9. Front wrench

Operator Orientation

IMPORTANT: Top view of unit is shown.

1. Front of unit
2. Right side of unit
3. Rear of unit
4. Left side of unit



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About This Manual

This manual contains information for the proper use of this machine. See the beige **Operation Overview** pages for basic operating procedures. Cross references such as "See page 50" will direct you to detailed procedures.

Bulleted Lists

Bulleted lists provide helpful or important information or contain procedures that do not have to be performed in a specific order.

Numbered Lists

Numbered lists contain illustration callouts or list steps that must be performed in order.

"Continued" Indicators

indicates that a procedure is continued on the next page.

Foreword

This manual is an important part of your equipment. It provides safety information and operation instructions to help you use and maintain your Ditch Witch equipment.

Read this manual before using your equipment. Keep it with the equipment at all times for future reference. If you sell your equipment, be sure to give this manual to the new owner.

If you need a replacement copy, contact your Ditch Witch dealer. If you need assistance in locating a dealer, visit our website at **www.ditchwitch.com** or write to the following address:

The Charles Machine Works, Inc.
Attn: Marketing Department
PO Box 66
Perry, OK 73077-0066
USA

The descriptions and specifications in this manual are subject to change without notice. The Charles Machine Works, Inc. reserves the right to improve equipment. Some product improvements may have taken place after this manual was published. For the latest information on Ditch Witch equipment, see your Ditch Witch dealer.

Thank you for buying and using Ditch Witch equipment.

JT520 (Tier 4i)
Operator's Manual

Issue number 1.1/OM-10/08
Part number 053-1219

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This product is covered by one or more of the following patents:
U.S. B1 4,858,704; 4,953,638; 5,148,880; 5,242,026; 5,341,887; 5,490,569; 5,684,466; 5,713,423; 5,794,719; 5,880,680; 5,941,322; 6,085,852; 6,109,371; 6,179,065; 6,216,803; 6,250,403; 6,250,404; 6,290,606; 6,311,790; 6,411,094; 6,543,551; 6,550,547; 6,672,409; 6,739,413; 6,761,231; 6,776,246; 6,808,210; 6,827,158; 6,848,506; 6,871,712; RE37,450; RE37,923; RE37,975; RE38,418; **AU** 689,533; 706,544; 718,034; 755,862; **CA** 2,156,398; 2,217,899; **DE** 694 17 019; 695 29 634; 297 01 406; **EP** 0683845; 0674093; 0817901; 0846841; 0927892; **FR** 674,093; **GB** 2,309,239; 2,312,006; EP674,093; EP846,841; **JP** 3,458,247; other U.S. and foreign patents pending.

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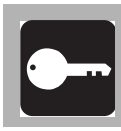
Overview 1
machine serial number, information about the type of work this machine is designed to perform, basic machine components, and how to use this manual

Foreword 5
part number, revision level, and publication date of this manual, and factory contact information

Safety 9
machine safety alerts and emergency procedures

Controls 19
machine controls, gauges, and indicators and how to use them



Operation Overview 39
an overview for completing a job with this machine: planning, setting up, installing product, and restoring the jobsite; with cross references to detailed procedures

Prepare 43
procedures for inspecting and classifying the jobsite, planning the installation path, and preparing the jobsite for work

Drive 59
procedures for startup, cold start, driving, and shutdown

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procedures for lifting, hauling, and towing

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procedures for drilling and backreaming

Systems and Equipment 85
downhole tools and drill pipe, anchor, electric strike, tracker control, and fluid systems

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procedures for restoring the jobsite and rinsing and storing equipment

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service intervals and instructions for this machine including lubrication, replacement of wear items, and basic maintenance

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machine specifications including weights, measurements, power ratings, and fluid capacities

Support **145**
the warranty policy for this machine, and procedures for obtaining warranty consideration and training

Service Record **149**
a record of major service performed on the machine

Safety

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Safety Alerts 12

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- Electric Strike Description 15
- If an Electric Line is Damaged 16
- If a Gas Line is Damaged 17
- If a Fiber Optic Cable is Damaged 18
- If Machine Catches on Fire 18

Guidelines

Follow these guidelines before operating any jobsite equipment:

- Complete proper training and read operator's manual before using equipment.
- Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.
- Classify jobsite based on its hazards and use correct tools and machinery, safety equipment, and work methods for jobsite.
- Mark jobsite clearly and keep spectators away.
- Wear personal protective equipment.
- Review jobsite hazards, safety and emergency procedures, and individual responsibilities with all personnel before work begins. Safety videos are available from your Ditch Witch dealer.
- Replace missing or damaged safety shields and safety signs.
- Use equipment carefully. Stop operation and investigate anything that does not look or feel right.
- Do not operate unit where flammable gas may be present.
- Contact your Ditch Witch dealer if you have any question about operation, maintenance, or equipment use.

Safety Alert Classifications

These classifications and the icons defined on the following pages work together to alert you to situations which could be harmful to you, jobsite bystanders or your equipment. When you see these words and icons in the book or on the machine, carefully read and follow all instructions. YOUR SAFETY IS AT STAKE.

Watch for the three safety alert levels: **DANGER**, **WARNING** and **CAUTION**. Learn what each level means.

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Watch for two other words: **NOTICE** and **IMPORTANT**.

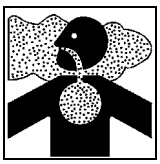
NOTICE can keep you from doing something that might damage the machine or someone's property. It can also alert you against unsafe practices.

IMPORTANT can help you do a better job or make your job easier in some way.

Safety Alerts

DANGER Turning shaft will kill you or crush arm or leg. Stay away.

DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.



DANGER Deadly gases. Lack of oxygen or presence of gas will cause sickness or death. Provide ventilation.

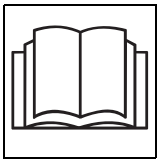
DANGER Moving tools will kill or injure. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

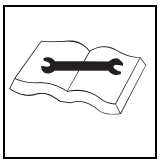
WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

WARNING Moving parts could cut off hand or foot. Stay away.

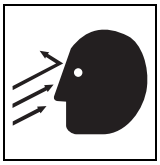
WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.



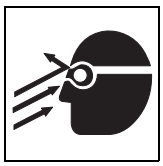
WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.



WARNING Improper control function could cause death or serious injury. If control does not work as described in instructions, stop machine and have it serviced.



WARNING Looking into fiber optic cable could result in permanent vision damage. Do not look into ends of fiber optic or unidentified cable.



WARNING Pressurized fluid or air could pierce skin and cause injury or death. Stay away.

WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark.

WARNING Moving traffic - hazardous situation. Death or serious injury could result. Avoid moving vehicles, wear high visibility clothing, post appropriate warning signs.

⚠ WARNING Hot pressurized cooling system fluid could cause serious burns. Allow to cool before servicing.

⚠ CAUTION Flying objects may cause injury. Wear hard hat and safety glasses.

⚠ CAUTION Hot parts may cause burns. Do not touch until cool.

⚠ CAUTION Exposure to high noise levels may cause hearing loss. Wear hearing protection.

⚠ CAUTION Fall possible. Slips or trips may result in injury. Keep area clean.

⚠ CAUTION Battery acid may cause burns. Avoid contact.

⚠ CAUTION Improper handling or use of chemicals may result in illness, injury, or equipment damage. Follow instructions on labels and in material safety data sheets (MSDS).

Emergency Procedures

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

Before operating any equipment, review emergency procedures and check that all safety precautions have been taken.

EMERGENCY SHUTDOWN - Turn ignition switch to stop position or push remote engine stop button (if equipped).

Electric Strike Description

DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

When working near electric cables, remember the following:

- Electricity follows all paths to ground, not just path of least resistance.
- Pipes, hoses, and cables will conduct electricity back to all equipment.
- Low voltage current can injure or kill. Many work-related electrocutions result from contact with less than 440 volts.

Most electric strikes are not noticeable, but indications of a strike include:

- power outage
- smoke
- explosion
- popping noises
- arcing electricity

If any of these occur, or if strike alarm sounds or flashes, assume an electric strike has occurred.

If an Electric Line is Damaged

If you suspect an electric line has been damaged and you are **on drilling unit or bonded ground mats**, DO NOT MOVE. Remain on drilling machine or mats and take the following actions. The order and degree of action will depend on the situation.

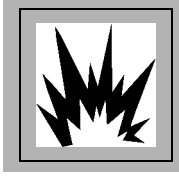
- Warn people nearby that an electric strike has occurred.
- Have someone contact electric company.
- Reverse drilling direction and try to break contact. Do not touch drill pipe with hands or hand-held tools.
- Press electric strike system status button.
    - If alarm sounds again, stay where you are and wait for electric company to shut off power.
    - If alarm does not sound and there is no other indication of a strike, wait at least one full minute before moving away from equipment. Utility might use automatic reclosers which will restart current flow. If alarm sounds again while waiting, stay where you are until electric company shuts off power.
    - If alarm does not sound but all lights in strike indicator are on, assume strike is continuing and stay where you are until electric company shuts off power.
- Do not resume drilling or allow anyone into area until given permission by electric company.

If you suspect an electric line has been damaged and you are **off drilling unit or bonded ground mats**, DO NOT TOUCH ANY EQUIPMENT connected to drilling unit. Take the following actions. The order and degree of action will depend on the situation.

- Stay where you are unless you are wearing electric insulating boots. If you leave, do not return to area or allow anyone into area until given permission by electric company.

If a Gas Line is Damaged

WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark.



WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.

If you suspect a gas line has been damaged, take the following actions. The order and degree of action will depend on the situation.

- Immediately shut off engine(s), if this can be done safely and quickly.
- Remove any ignition source(s), if this can be done safely and quickly.
- Warn others that a gas line has been cut and that they should leave the area.
- Leave jobsite as quickly as possible.
- Immediately call your local emergency phone number and utility company.
- If jobsite is along street, stop traffic from driving near jobsite.
- Do not return to jobsite until given permission by emergency personnel and utility company.

If a Fiber Optic Cable is Damaged

Do not look into cut ends of fiber optic or unidentified cable. Vision damage can occur.

If Machine Catches on Fire

Perform emergency shutdown procedure and then take the following actions. The order and degree of action will depend on the situation.

- Immediately move battery disconnect switch (if equipped) to disconnect position.
- If fire is small and fire extinguisher is available, attempt to extinguish fire.
- If fire cannot be extinguished, leave area as quickly as possible and contact emergency personnel.

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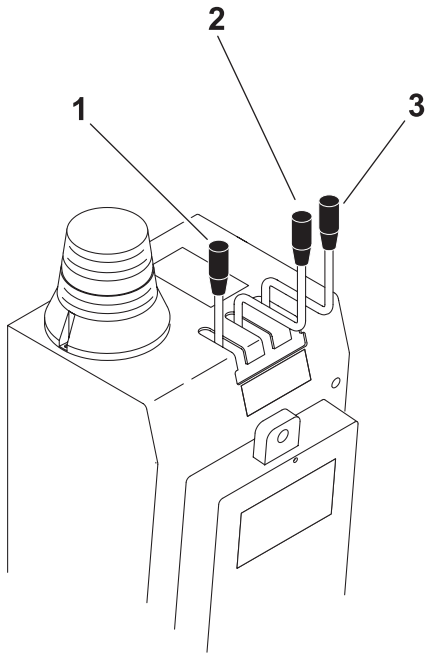
Set-Up Console



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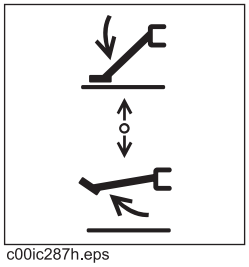
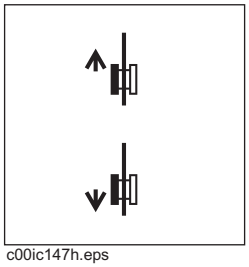
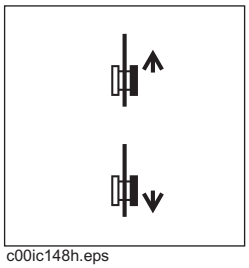
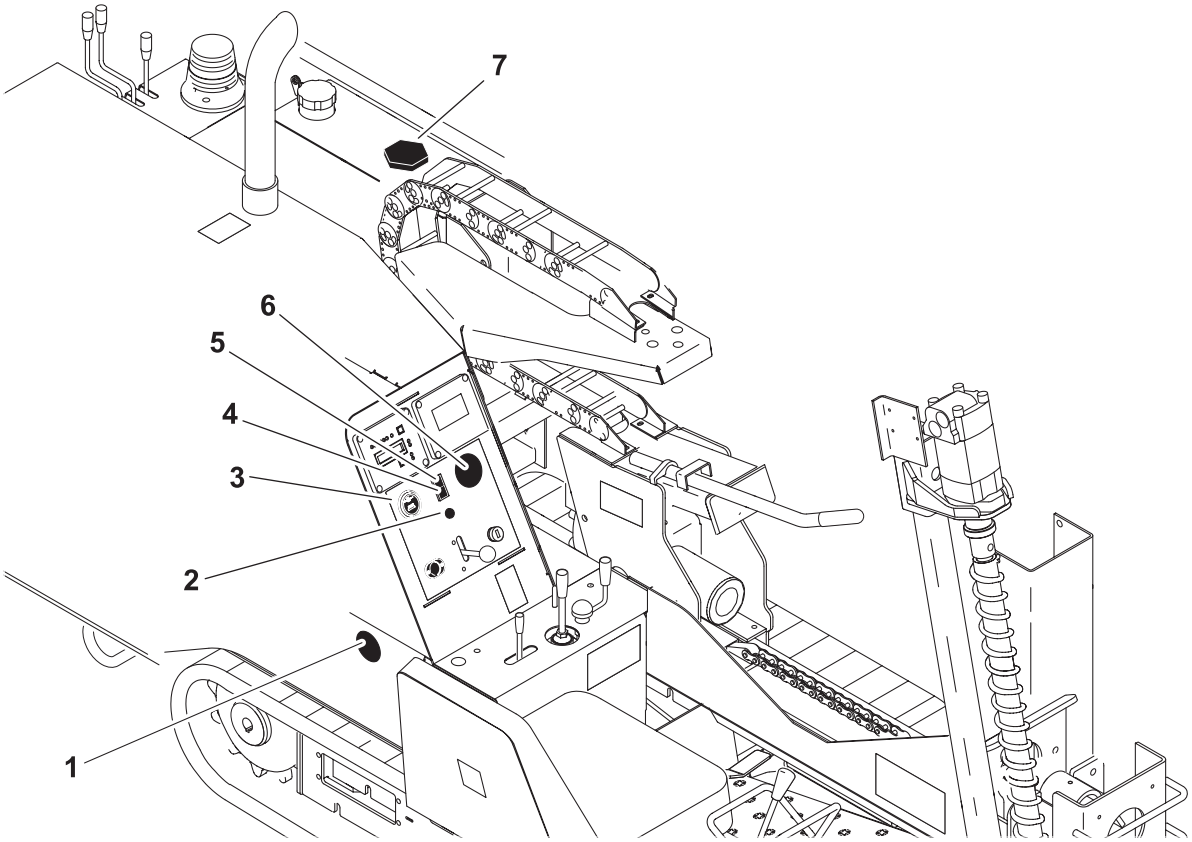
1. Stabilizer and frame tilt control
2. Left track control
3. Right track control

Item	Description	Notes
1. Stabilizer and frame tilt control  c00ic287h.eps	To raise stabilizer and decrease frame tilt, pull. To lower stabilizer and increase frame tilt, push.	.

Item	Description	Notes
2. Left track control  c00ic147h.eps	To move forward, push. To move backward, pull. To stop, move to center.	
3. Right track control  c00ic148h.eps	To move forward, push. To move backward, pull. To stop, move to center.	

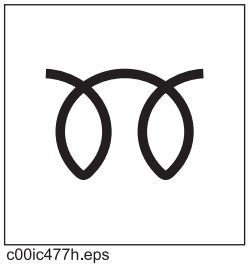
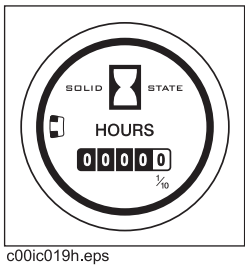
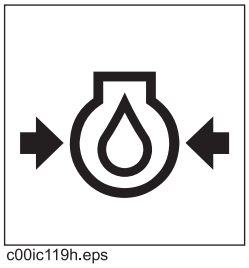
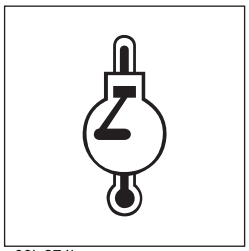
Operator's Station

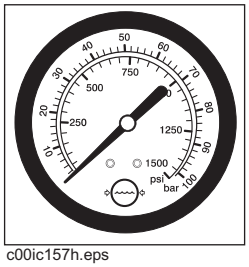
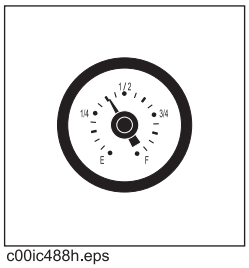
Gauges and Indicators



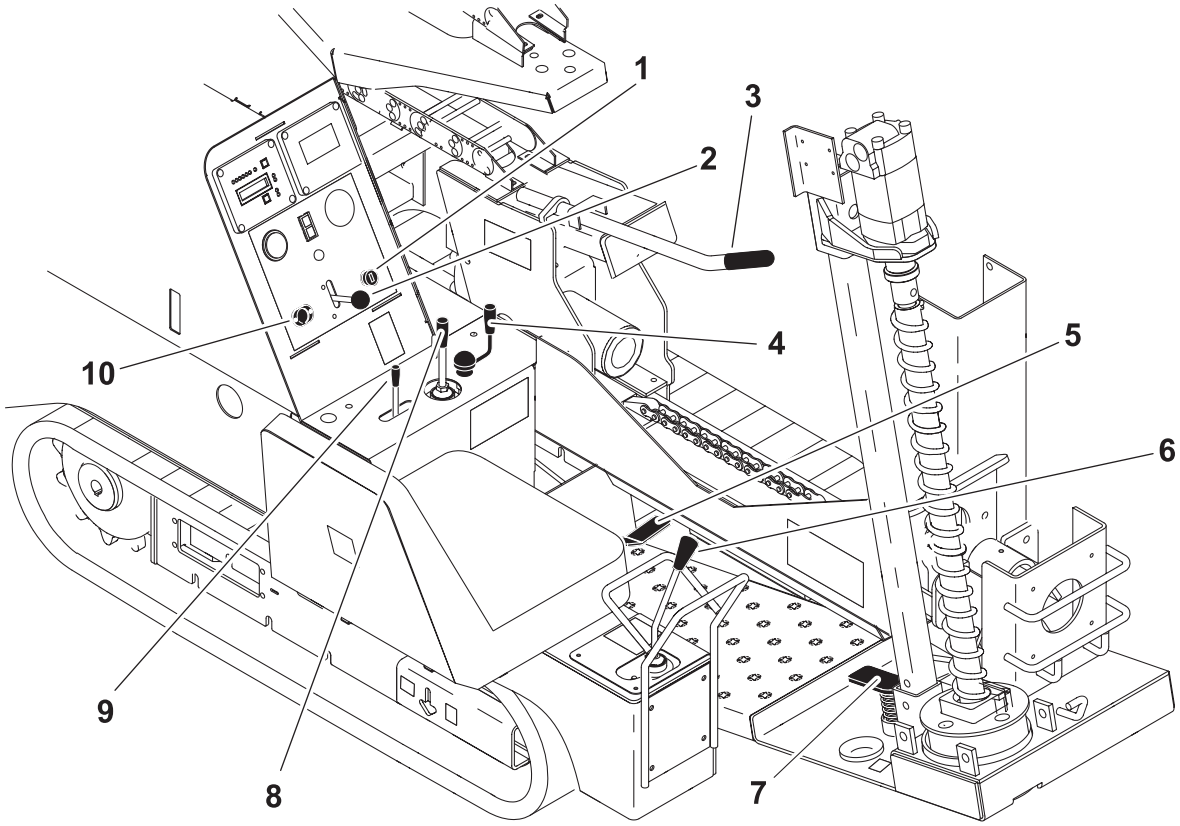
1. Hydraulic fluid sight glass
2. Glow plug indicator
3. Hourmeter
4. Engine oil pressure indicator
5. Engine temperature indicator
6. Drilling fluid pressure gauge
7. Fuel gauge

Item	Description	Notes
1. Hydraulic fluid sight glass	Displays level of hydraulic fluid.	Maintain level in center of glass.

Item	Description	Notes
2. Glow plug indicator  c00ic477h.eps	Lights when glow plugs are operating. Wait until light goes off before starting engine.	
3. Hourmeter  c00ic019h.eps	Displays engine operating time.	Use engine operating times to schedule service.
4. Engine oil pressure indicator  c00ic119h.eps	Indicates engine oil pressure is too low.	Stop engine and check oil level.
5. Engine temperature indicator  c00ic274h.eps	Indicates engine is overheating.	Stop engine and service unit.

Item	Description	Notes
6. Drilling fluid pressure gauge  c00ic157h.eps	Displays drilling fluid pressure supplied by drilling fluid pump.	
7. Fuel gauge  c00ic488h.eps	Displays fuel level.	**IMPORTANT:** Use low sulfur or ultra low sulfur fuel only.

Controls



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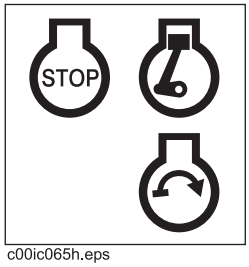
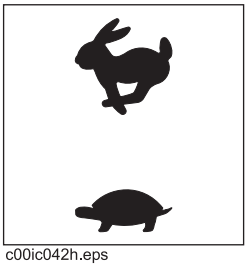
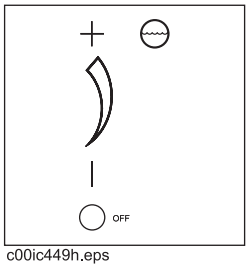
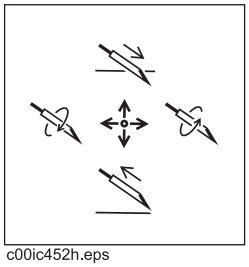
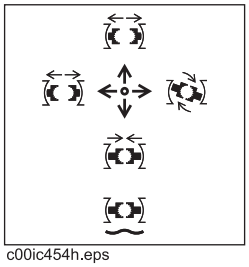
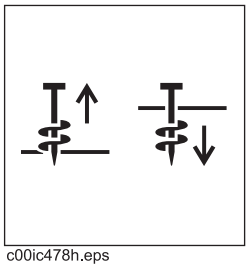
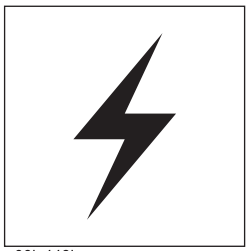
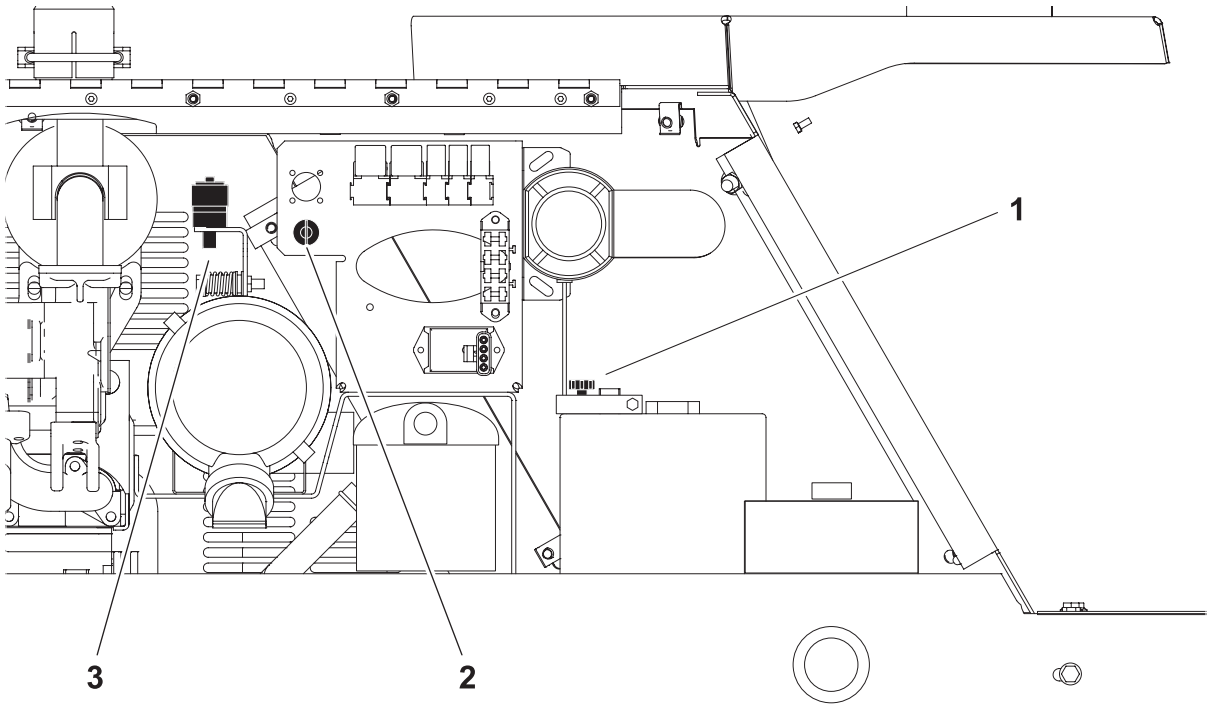
1. Ignition switch
2. Engine throttle control
3. Auxiliary wrench handle
4. Fluid flow control
5. Pipe lubricator control
6. Carriage control
7. Anchor collar rotation lock control
8. Wrench control
9. Anchor control
10. Auxiliary outlet

Item	Description	Notes
1. Ignition switch  c00ic065h.eps	To start engine, insert key and turn clockwise. To stop engine, turn key counterclockwise.	

Item	Description	Notes
2. Engine throttle control  c00ic042h.eps	To increase engine speed, push up. To decrease engine speed, pull down.	
3. Auxiliary wrench handle	To engage auxiliary wrench, lower over wrench flats. To disengage, raise.	
4. Fluid flow control  c00ic449h.eps	To increase flow, turn counterclockwise. To decrease flow, turn clockwise. To stop flow, turn all the way clockwise.	
5. Pipe lubricator control	To apply joint compound a front wrench, press pedal.	**IMPORTANT:** Manually apply joint compound at carriage.
6. Carriage control  c00ic452h.eps	To move carriage forward, push. To move carriage backward, pull. To rotate spindle counterclockwise (breakout), move right. To rotate spindle clockwise (makeup), move left.	
7. Anchor collar rotation lock control	To allow anchor collar to rotate freely, press pedal. To prevent anchor collar rotation, release pedal. Collar will rotate until pin engages in hole.	

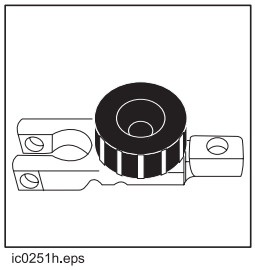
Item	Description	Notes
8. Wrench control  c00ic454h.eps	To clamp front wrench and shut off drilling fluid, move toward pipebox. To unclamp front wrench, move away from pipebox. To clamp and rotate rear (rotating) wrench, move toward engine compartment. To unclamp rear (rotating) wrench, move toward seat.	
9. Anchor control  c00ic478h.eps	To drive anchor, push. To remove anchor, pull.	
10. Auxiliary outlet  c00ic448h.eps	Provides power for other equipment.	Power output is 12V, 5A.

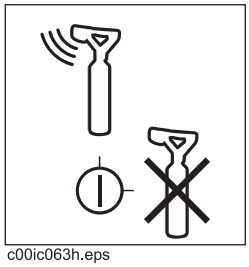
Engine Compartment



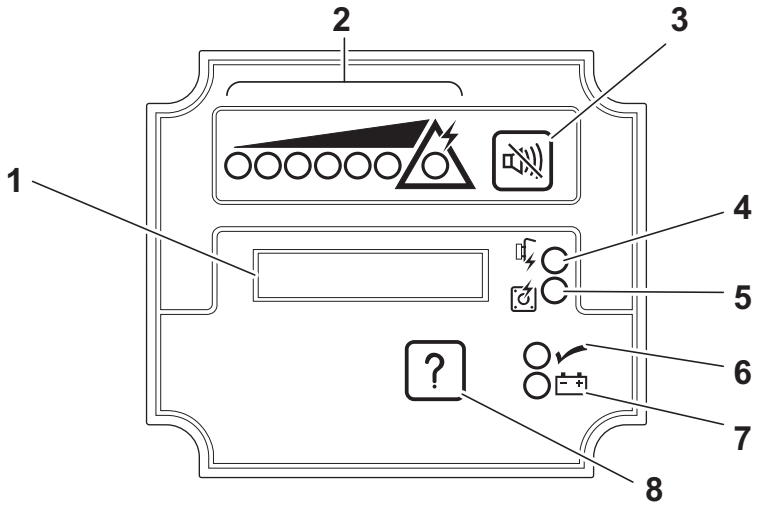
j25om040h.eps

1. Battery disconnect switch
2. Tracker control switch
3. Air filter service indicator

Item	Description	Notes
1. Battery disconnect switch  ic0251h.eps	To connect, turn clockwise. To disconnect, turn counterclockwise.	

Item	Description	Notes
2. Tracker control key  c00ic063h.eps	To allow tracker operator to stop thrust and rotation, move key to enable position (up). To override tracker control mode, move key to disable position (right).	**IMPORTANT:** Remove key and keep in tracker operator's possession.
3. Air filter service indicator	Indicates when to change air filter. Press button to reset indicator after changing filter.	

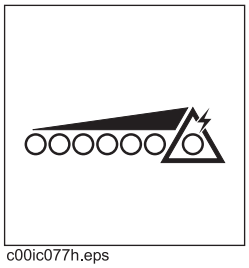
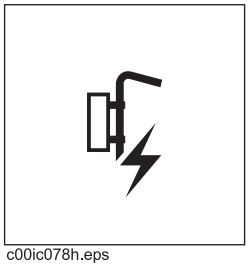
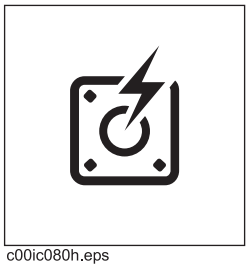
ESID

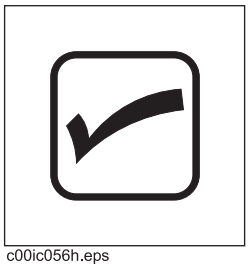
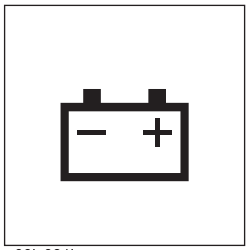


j07om042h.eps

1. Alphanumeric display
2. Strike indicator
3. Alarm interrupt button
4. Voltage problem indicator
5. Current problem indicator
6. OK indicator
7. Electrical power supply indicator
8. Self test button

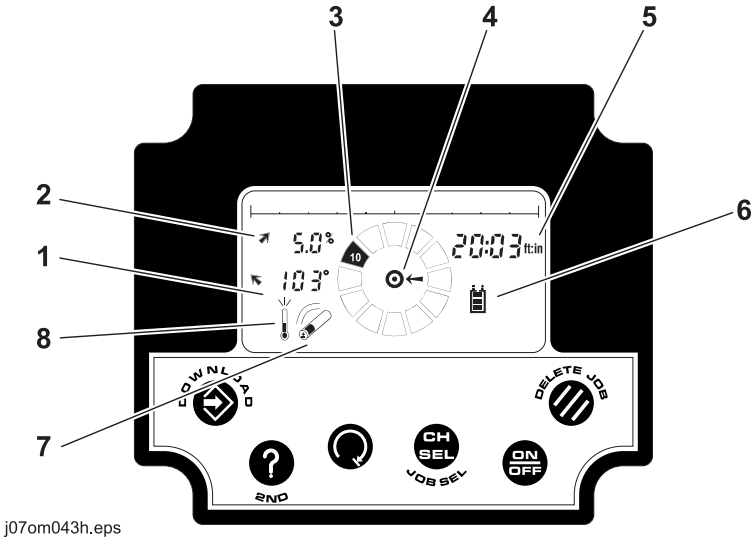
Item	Description	Notes
1. Alphanumeric display	Display amount of current and voltage being detected as a percentage of strike condition. The line with the "V" shows voltage reading and the line with the "A" shows current reading.	

Item	Description	Notes
2. Strike indicator  c00ic077h.eps	Red lights come on as values in display increase. Light in triangle represents strike warning condition and will trigger alarm(s) and strobe(s). Remember that system can go from one or two lights to an electric strike immediately.	**NOTICE:** The ESID does not indicate proximity to electric lines. System will activate only when voltage and/or amperage detected at the drilling unit are above threshold minimum limits.
3. Alarm interrupt button c00ic078h.eps	To turn off strike alarm at drilling unit, press.	
4. Voltage problem indicator  c00ic078h.eps	Blinking red light indicates a voltage indicator problem.	See "Troubleshoot Strike System" on page 90.
5. Current problem indicator  c00ic080h.eps	Blinking red light indicates a current indicator problem.	See "Troubleshoot Strike System" on page 90.

Item	Description	Notes
6. OK indicator  c00ic056h.eps	Green light means system self test detected no problems. Strike system is ready to operate.	
7. Electrical power supply indicator  c00ic081h.eps	Green light means control box has sufficient electrical power for operation. Strike system is ready to operate if OK indicator is also on.	
8. Self test button c00ic075h.eps	To start manual self test, press. To reset system after a strike has been detected, press.	Checks all systems and circuits. **NOTICE:** See "If an Electric Line is Damaged" on page 16.

750/752 Display

Indicators

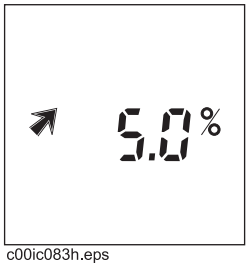
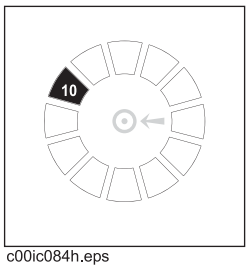
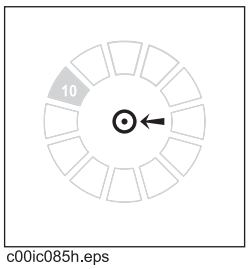


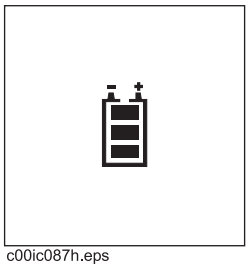
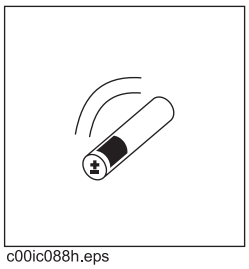
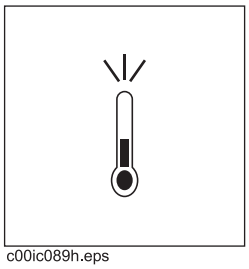
j07om043h.eps

1. Beacon temperature display
2. Pitch/slope indicator and percentage indicator
3. Roll indicator
4. Target indentifier indicator
5. Depth estimate
6. Display battery status indicator
7. Beacon battery status indicator
8. Beacon temperature indicator

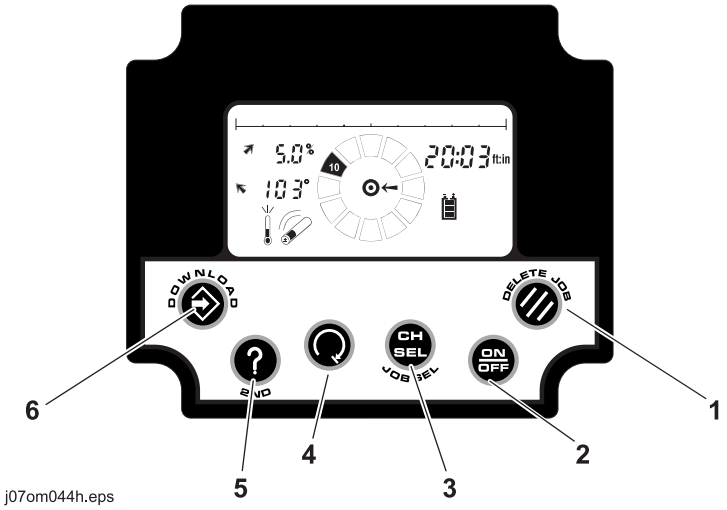
IMPORTANT: Some items operate differently depending where data is being saved. **Internal** refers to pipe data being saved to 750 Display memory. **External** refers to pipe data being sent to a properly connected laptop computer running a version of Trac Management System software.

Item	Description	Notes
1. Beacon temperature display c00ic286h.eps	Shows beacon temperature readings in degrees Farenheit and degrees Centigrade.	

Item	Description	Notes
2. Pitch/slope indicator and percentage indicator  c00ic083h.eps	Indicates pitch beacon percent of grade.	**Internal**: shows pipe label and stored pitch. **External**: shows desired pitch.
3. Roll indicator  c00ic084h.eps	Indicates beacon roll angle.	
4. Target identifier indicator  c00ic085h.eps	Indicates approximate beacon location.	Only one set of arrows is active at a time.
5. Depth estimate c00ic086h.eps	Indicates beacon depth estimate.	**Internal**: shows job number and stored depth. **External**: shows desired depth.

Item	Description	Notes
6. Display battery status indicator  c00ic087h.eps	Indicates display power from drilling unit.	If all five bars are not showing, check display power connections.
7. Beacon battery status indicator  c00ic088h.eps	Indicates beacon battery status.	See beacon instruction sheet.
8. Beacon temperature indicator  c00ic089h.eps	Indicates beacon temperature.	See beacon instruction sheet.

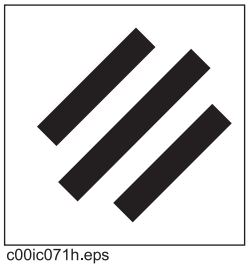
Controls

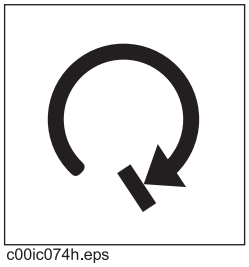


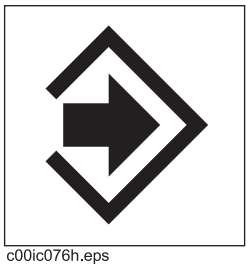
j07om044h.eps

1. Delete button
2. On/Off button
3. Channel select button
4. Roll stop button
5. Recall button
6. Store button

IMPORTANT: Some items operate differently depending where data is being saved. **Internal** refers to pipe data being saved to 750 Display memory. **External** refers to pipe data being sent to a properly connected laptop computer running a version of Trac Management System software.

Item	Description	Notes
1. Delete button  c00ic071h.eps	To delete current pipe, press. **Second function:** To delete all jobs in internal logging memory, press with Recall button.	Previous pipe number will appear in numeric display when data is deleted.
2. On/Off button c00ic112h.eps	To turn on, press. To turn off, press again.	

Item	Description	Notes
3. Channel select button c00ic073h.eps	To display current channel, press and release. To switch channels, press and hold. **Second function:** To start a new job, press with Recall button. "Init" and job number will be displayed.	Unit defaults to last channel used each time unit is turned on. **IMPORTANT:** Make sure display and tracker are set to the same channel.
4. Roll stop button  c00ic074h.eps	This feature is not yet available.	
5. Recall button c00ic075h.eps	To see data about pipe, press and release. **Second function:** To access second functions, press with other buttons.	**Internal**: shows data about previous pipe. **External**: shows data about next pipe.

Item	Description	Notes
6. Store button  c00ic076h.eps	To display serial number, press and hold while pressing on/off button. To store current pipe data, press. **Second function:** To download all jobs stored in internal logging memory: • Press with Recall button • Connect display to PC running Trac Management System software.	Pipe number will appear in numeric display when data is stored. **IMPORTANT:** Pipe data cannot be stored without a valid depth estimate.

Operation Overview

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Storing Equipment 42

Planning

1. Gather information about jobsite. See page 45.
2. Inspect jobsite. See page 46.
3. Classify jobsite. See page 48.
4. Plan bore path. See page 50.
5. Check supplies and prepare equipment. See page 56.
6. Load equipment. See page 66.

Setting Up at Jobsite

1. Prepare jobsite. See page 55.
2. Unload drilling unit from trailer. See page 68.
3. Assemble drill string. See page 75.
4. Position drilling unit and frame. See page 73.
5. Assemble strike system. See page 88.
6. Anchor drilling unit. See page 87.
7. Calibrate tracker with beacon that will be installed in beacon housing. See tracker operator's manual.

Drilling

1. Start system. See page 73.
2. Prime drilling fluid pump. See page 73.
3. Engage tracker control if desired. See page 99.
4. Drill first pipe. See page 77.
5. Record bore path. See page 80.
6. Add pipe. See page 78.
7. Drill remaining pipes in pipe box and correct direction (page 79) as necessary.
8. Surface drill head. See page 81.

Backreaming

1. Assemble backream string. See page 82.
2. Start drilling unit and adjust throttle.
3. Set drilling fluid flow. Check that fluid flows through all nozzles. See page 94.
4. Remove pipe from bore. See page 83.
5. Remove pullback device. See page 84.

Backreaming Tips

- Plan backreaming job before drilling. Plan bore path as straight as possible. Check bend limits of pullback material. Check that appropriate pullback devices are on hand.
- Keep all bends as gradual as possible.
- Drilling fluid quality is a key factor in backreaming success. Contact your Ditch Witch dealer for information on testing water, selecting additives, and mixing drilling fluid.
- Backreaming requires more fluid than drilling. Make sure enough fluid is used.

Leaving Jobsite

1. Remove downhole tools. See page 84.
2. Remove anchors. See page 87.
3. Rinse unit and downhole tools. See page 115.
4. Disassemble strike system and disconnect from fluid system. See page 115.
5. Stow tools. See page 115.
6. Load unit onto trailer. See page 66.

Storing Equipment

1. For cold weather storage, antifreeze drilling unit. See page 114.
2. For long-term storage, disconnect battery disconnect switch.

Prepare

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- Examine Pullback Material 45
- Arrange for Traffic Control 45
- Plan for Emergency Services 45

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- Prepare Entry Point. 55

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- Check Supplies 56
- Prepare Equipment 57
- Assemble Accessories 57

Gather Information

A successful job begins before the bore. The first step in planning is reviewing information already available about the job and jobsite.

Review Job Plan

Review blueprints or other plans and make sure you have taken bore enlargement during backreaming and pullback into account. Check for information about existing or planned structures, elevations, or proposed work that may be taking place at the same time.

Notify One-Call Services

Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.

Examine Pullback Material

Ask for a sample of the material you will be pulling back. Check its weight and stiffness. Contact the manufacturer for bend radius information. Check that you have appropriate pullback devices.

Arrange for Traffic Control

If working near a road or other traffic area, contact local authorities about safety procedures and regulations.

Plan for Emergency Services

Have the telephone numbers for local emergency and medical facilities on hand. Check that you will have access to a telephone.

Inspect Site

Inspect jobsite before transporting equipment. Check for the following:

- overall grade or slope
- changes in elevation such as hills or open trenches
- obstacles such as buildings, railroad crossings, or streams
- signs of utilities (See "Inspect Jobsite" on page 48.)
- traffic
- access
- soil type and condition
- water supply
- sources of locator interference (rebar, railroad tracks, etc.)

Take soil samples from several locations along bore path to determine best bit and backreamer combinations.

Identify Hazards

Identify safety hazards and classify jobsite. See "Classify Jobsite" on page 48.

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

NOTICE:

- Wear personal protective equipment including hard hat, safety eye wear, and hearing protection.
- Do not wear jewelry or loose clothing.
- Notify One-Call and companies which do not subscribe to One-Call.
- Comply with all utility notification regulations before digging or drilling.
- Verify location of previously marked underground hazards.
- Mark jobsite clearly and keep spectators away.

Remember, jobsite is classified by hazards in place -- not by line being installed.

Select Start and End Points

Select one end to use as a starting point. Consider the following when selecting a starting point:

Slope

Fluid system should be parked on a level site. Consider how slope will affect drilling unit setup, bending pipe, and fluid flow out of hole.

Traffic

Vehicle and pedestrian traffic must be a safe distance from drilling equipment. Allow at least 10' (3 m) buffer zone around equipment.

Space

Check that starting and ending points allow enough space for gradual pipe bending. See "Minimum Setback" on page 53.

Check that there is enough space to work and to set up electric strike system.

Comfort

Consider shade, wind, fumes, and other site features.

Drill downhill when possible so fluid will flow away from drilling unit.

Classify Jobsite

Inspect Jobsite

- Follow U.S. Department of Labor regulations on excavating and trenching (Part 1926, Subpart P) and other similar regulations.
- Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.
- Inspect jobsite and perimeter for evidence of underground hazards, such as:
  - "buried utility" notices
  - utility facilities without overhead lines
  - gas or water meters
  - junction boxes
  - drop boxes
  - light poles
  - manhole covers
  - sunken ground
- Have an experienced locating equipment operator sweep area within 20' (6 m) to each side of bore path. Verify previously marked line and cable locations.
- Mark location of all buried utilities and obstructions.
- Classify jobsite.

Select a Classification

Jobsites are classified according to underground hazards present.

If working . . .	then classify jobsite as . . .
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in concrete, sand or granite which is capable of producing crystalline silica (quartz) dust	crystalline silica (quartz) dust
within 10' (3 m) of any other hazard	other

NOTICE: If you have any doubt about jobsite classification, or if jobsite might contain unmarked hazards, take steps outlined previously to identify hazards and classify jobsite before working.

Apply Precautions

Once classified, precautions appropriate for jobsite must be taken.

Electric Jobsite Precautions

In addition to using a directional drilling system with an electric strike system, use one or both of these methods.

- Expose line by careful hand digging or soft excavation. Use beacon to track bore path.
- Have service shut down while work is in progress. Have electric company test lines before returning them to service.

Natural Gas Jobsite Precautions

In addition to using a directional drilling system and positioning equipment upwind from gas lines, use one or both of these methods.

- Expose lines by careful hand digging or soft excavation. Use beacon to track bore path.
- Have gas shut off while work is in progress. Have gas company test lines before returning them to service.

Crystalline Silica (Quartz) Dust Precautions

Follow OSHA or other guidelines for exposure to crystalline silica when trenching, sawing or drilling through material that might produce dust containing crystalline silica (quartz).

Other Jobsite Precautions

You may need to use different methods to safely avoid other underground hazards. Talk with those knowledgeable about hazards present at each site to determine which precautions should be taken or if job should be attempted.

Plan Bore Path

Plan the bore path, from entry to end, before drilling begins. The Ditch Witch **Trac Management System Plus** is available for planning your bore path. This special software can be run in the field using a laptop computer equipped with Windows® 95 or higher operating system. See your Ditch Witch dealer for details.

If not using Trac Management System Plus, mark the bore path on the ground with spray paint or flags, or record it on paper for operator reference.

For complicated bores, consult an engineer. Have the jobsite surveyed and bore path calculated. Be sure the engineer knows minimum entry pitch, bend limits of drill pipe, bend and tension limits of pullback material, pipe lengths, and location of all underground utilities.

For less complicated bores, plan the bore based on four measurements:

- recommended bend limit
- entry pitch
- minimum setback
- minimum depth

IMPORTANT: See the following pages for more information about these measurements. If not using Trac Management System Plus, see "Bore Path Calculator" on page 54 and use these measurements to help plan your bore.

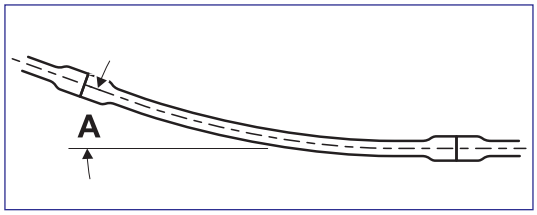
Recommended Bend Limits

Ditch Witch drill pipes are designed to bend slightly during operation. Slight bending allows for steering and correcting direction. Bending beyond recommended limits will cause damage that might not be visible. This damage adds up and will later lead to sudden drill pipe failure.

IMPORTANT: Consider recommended bend limits during any bend, not just during bore entry.

Pipe Pitch

Ditch Witch drill pipe is tested to bend at a maximum percent pitch. For JT520 drill pipe, make sure pitch (A) changes no more than **7%** over the full length of each pipe.



j07om003c.eps

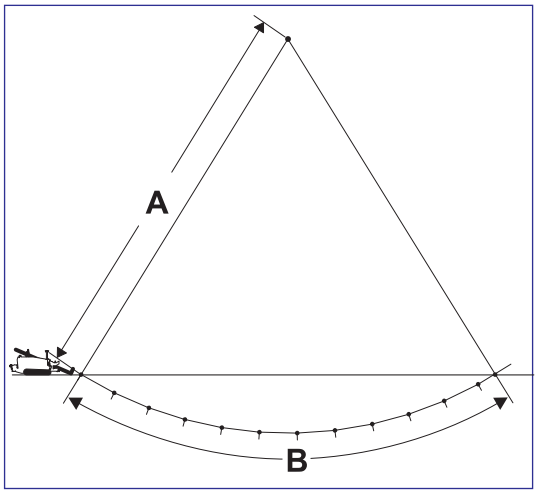
NOTICE: Bending drill pipe more sharply than recommended will damage pipe and cause failure over time. Changes in pitch must be **equally distributed** over the length of a pipe. Maximum changes in pitch within 1-2' (300-600 mm) of pipe create sharp bends that will damage pipe.

Monitor the pitch of each pipe with the 750/752 Display on the operator's console. See page 49.

Bend Radius

JT520 drill pipes have a tested minimum bend radius of 70' (21.3 m). This means that a 90-degree bend in the bore path:

- has a radius (A) of 70' (21.3 m)
- requires approximately 110' (33.5 m) of drill pipe (B).



j07om078h.eps

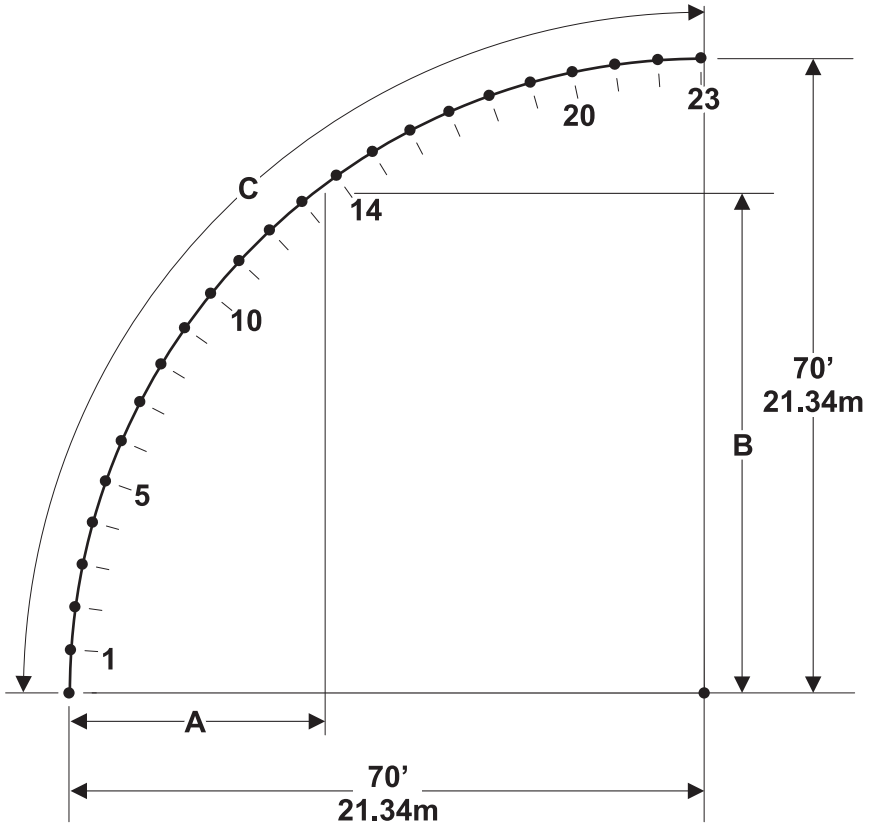
NOTICE: Bending drill pipe more sharply than recommended will damage the pipe and cause failure over time.

- If bend radius is reduced, drill pipe life is reduced.
- If bend radius is increased, drill pipe life is increased.

IMPORTANT: Use the charts on the next page to keep bends within safe limits.

Pipe-By-Pipe Bend Limits

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	4' 11" (1.5 m)	0' 2" (.05 m)	**13**	55' 5" (16.9 m)	27' 3" (8.3 m)
2	9' 10" (3.0 m)	0' 8" (.2 m)	**14**	58' 4" (17.8 m)	31' 3" (9.5 m)
3	14' 8" (4.5 m)	1' 7" (.5 m)	**15**	60' 11" (18.6 m)	35' 5" (10.8 m)
4	19' 5" (5.9 m)	2' 9" (.8 m)	**16**	63' 2" (19.3 m)	39' 8" (12.1 m)
5	24' 1" (7.4 m)	4' 3" (1.3 m)	**17**	65' 1" (19.9 m)	44' 4" (13.5 m)
6	28' 8" (8.7 m)	6' 2" (1.9 m)	**18**	66' 9" (20.4 m)	48' 11" (14.9 m)
7	33' 1" (10.1 m)	8' 4" (2.5 m)	**19**	68' 1" (20.8 m)	53' 8" (16.4 m)
8	37' 4" (11.4 m)	10' 9" (3.3 m)	**20**	69' 1" (21.1 m)	58' 6" (17.8 m)
9	41' 5" (12.6 m)	13' 7" (4.1 m)	**21**	69' 8" (21.2 m)	63' 4" (19.3 m)
10	45' 3" (13.8 m)	16' 7" (5.1 m)	**22**	69' 11" (21.3 m)	68' 4" (20.8 m)
11	48' 11" (14.9 m)	19' 11" (6.1 m)	**23**	70' 0" (21.4 m)	70' 0" (21.3 m)
12	52' 4" (15.9 m)	23' 6" (7.2 m)			



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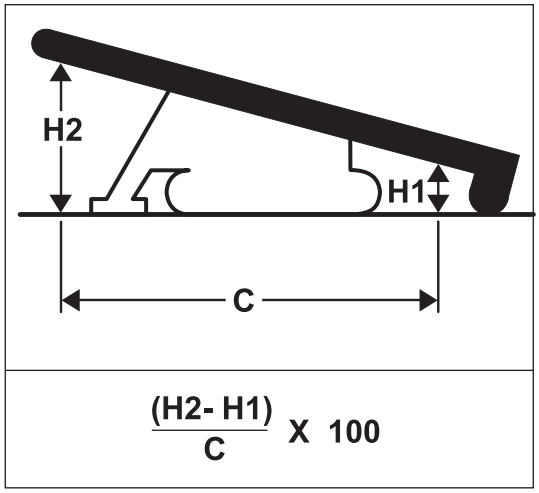
Pipe 13 is illustrated.

Entry Pitch

Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of two ways:

1. **With Pitch Beacon**
   - Lay pitch beacon on the ground and read pitch.
   - Lay pitch beacon on drill frame and read pitch.
   - Subtract ground pitch from drilling unit pitch.
2. **With Measurements**
   - Measure from the ground to front end of drill frame (H1).
   - Measure from the ground to back end of frame (H2).
   - Subtract (H1) from (H2). Record this number.
   - Measure the distance between front and back points (C).
   - Divide (H2-H1) by (C), then multiply by 100. This is your pitch.



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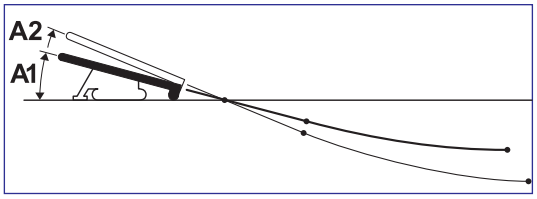
IMPORTANT: A shallow entry pitch (A1) allows you to reach horizontal sooner and with less bending. Increasing entry pitch (A2) makes bore path longer and deeper.



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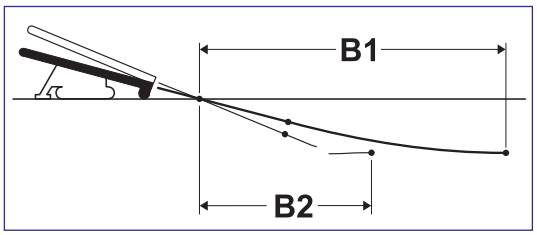
Minimum Setback

Setback is the distance from the entry point to where pipe becomes horizontal (B1).

NOTICE: If setback is too small (B2), you will exceed bend limits and damage the pipe.



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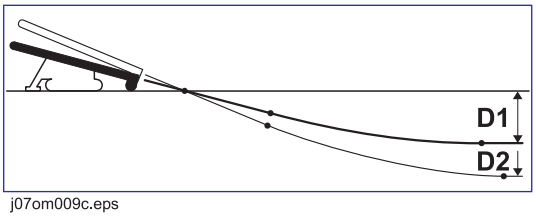
Minimum Depth



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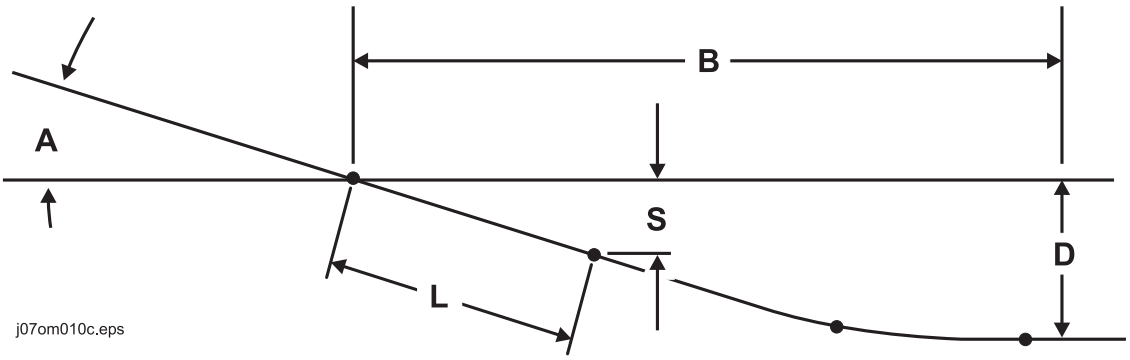
Because you must bend pipe gradually, entry pitch and bend limits determine how deep the pipe will be when it becomes horizontal. This is called the **minimum depth**.

- To reduce minimum depth (D1), reduce entry pitch. This also decreases setback.
- To increase minimum depth (D2), increase entry pitch. This also increases setback.

Bore Path Calculator

Entry pitch, setback, and minimum depth work together with bend limits to determine the bore path. To find the setback (B) and entry pitch (A) that will take you to the desired minimum depth (D), use the chart below.



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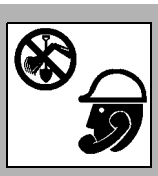
Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
2' 0" (0.6 m)	-18%	17' 4" (5.3 m)	0' 11" (0.28 m)
2' 4" (0.7 m)	-20%	18' 8" (5.7 m)	1' 0" (0.30 m)
2' 9" (0.8 m)	-22%	19' 11" (6.1 m)	1' 1" (0.33 m)
3' 1" (0.9 m)	-24%	21' 2" (6.5 m)	1' 2" (0.36 m)
3' 6" (1.1 m)	-26	22' 5" (6.8 m)	1' 3" (0.38 m)
3' 11" (1.2 m)	-28	23' 8" (7.2 m)	1' 4" (0.41 m)
4' 5" (1.4 m)	-30	24' 11" (7.6 m)	1' 5" (0.43 m)

IMPORTANT: Numbers in table based on **70' (21.3 m) minimum bend radius**, beacon housing, EZ-Connect, connector, transition sub, and 1/3 of first drill pipe (L, totaling 5' [1.5 m]) in the ground before steering.

Prepare Jobsite



WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

NOTICE:

- If jobsite classification is in question or if the possibility of unmarked electric utilities exists, classify jobsite as electric.
- Cutting high voltage cable can cause electrocution. Expose lines by hand before digging.
- All vegetation near operator's station must be removed. Contact with trees, shrubs, or weeds during electrical strike could result in electrocution.

Mark Bore Path

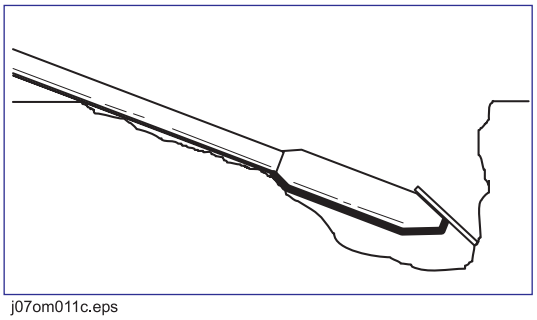
Mark your planned bore path and all located utility lines with flags or paint.

Prepare Entry Point

For bore to be successful, first pipe must be straight as it enters the ground.

To help ensure that the first pipe does not bend, dig a small starting hole so that the first pipe is drilled into a vertical surface.

To prevent bending or straining pipe, position drilling unit for straight entry.



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Check Supplies and Prepare Equipment

Check Supplies

- receiver/transmitter or tracker with spare batteries
- beacons with new and spare batteries
- two-way radios with new and spare batteries
- quick wrench (see page 107)
- transition sub
- anchoring equipment and accessories
- bits, screens, nozzles (see page 102)
- adapters, pipe, beacon housings
- marking flags or paint
- water and additional hoses
- fuel (Use low sulfur or ultra low sulfur fuel only.)
- drilling fluid additives (see page 94)
- spare fuses
- keys
- backreamers, swivels, pulling devices (see page 102)
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound (see page 120)
- electrically insulating boots and gloves
- personal protective equipment, such as hard hat and safety glasses
- notepad and pencil

Prepare Equipment

Fluid Levels

- fuel (Use low sulfur or ultra low sulfur fuel only.)
- hydraulic fluid
- engine coolant
- battery charge
- engine oil

Condition and Function

- filters (air, oil, hydraulic)
- fluid pump
- couplers
- tires and tracks
- pumps and motors
- drilling fluid mixer
- hoses and valves
- water tanks

Assemble Accessories

Fire Extinguisher

If required, mount a fire extinguisher near the power unit but away from possible points of ignition. The fire extinguisher should always be classified for both oil and electric fires. It should meet legal and regulatory requirements.

Drive

Chapter Contents

Start Unit 60

Steer Unit 60

Shut Down Unit 61

Start Unit

1. Insert key.
2. Turn key clockwise. See page 25 for more information.
3. Run engine at low throttle for 5 minutes.

Steer Unit

To steer drilling unit, follow instructions for type of steering desired. See page 20 for more information.

To steer while moving forward, move one control slightly more than the other to turn in the desired direction. Drilling unit will gradually turn to left or right.

To steer while moving backward, move one control slightly more than the other to turn in the desired direction. Drilling unit will gradually turn to left or right.

For tight steering at low speed, one control to reverse and one control to forward to turn in the desired direction. Tracks will counter-rotate and turn drilling unit in a tight circle.

Tips to Reduce Track Wear

Rubber tracks are best suited at soil-based job sites with minimal rock and debris. Sharp objects such as gravel, steel shards, and broken concrete will damage rubber tracks and undercarriage components. Excessive operation on concrete or asphalt will shorten track life. When storing your machine, keep tracks away from rain and direct sunlight.

Wash tracks daily to remove foreign objects and abrasive soil from sprockets and idler rollers. Drive slowly and make wide turns when possible. Regularly check undercarriage components (sprocket, rollers, idler) for wear and damage. Maintain proper track tension. (See “Check Track Tension and Condition” on page 137.)

To prevent premature wear, avoid the following:

- Spinning tracks under heavy load.
- Turning on sharp objects such as stones, stumps and debris.
- Quick turns or “spin” turns on asphalt or concrete.
- Driving over curbs, ledges, and sharp objects.
- Driving with sidewall edges pressed against hard walls, curbs or other objects.
- Driving on slopes.
- Operating on corrosive materials such as salt or fertilizer. Wash immediately.

Shut Down Unit

1. Stop track movement.
2. Lower drill frame and stabilizer to the ground.

IMPORTANT: If frame and stabilizer cannot be lowered, use cylinder locks or other suitable material to block the tracks. Remove cylinder locks or chocks before driving unit.

3. Run engine at low throttle for 3 minutes to cool.
4. Turn key to STOP.
5. Remove key.

Transport

Chapter Contents

Lift 64

- Points 64
- Procedure 65

Haul 66

- Load 66
- Tie Down 67
- Unload 68

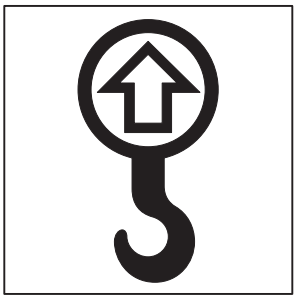
Tow 69

Lift

WARNING Crushing weight. If load falls or moves it could kill or crush you. Use proper procedures and equipment or stay away.

Points

Lifting points are identified by lifting decals. Lifting at other points is unsafe and can damage machinery.



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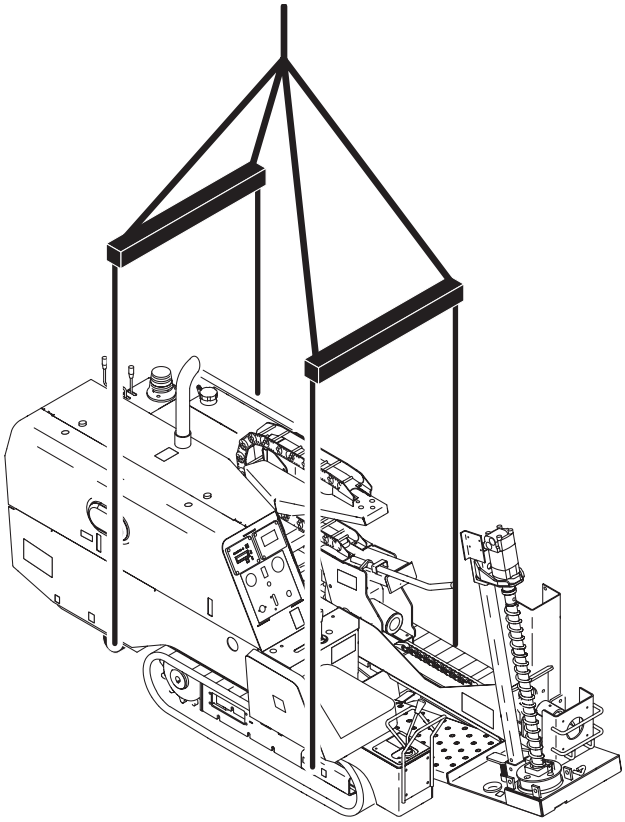
Procedure



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Use a crane capable of supporting the equipment's size and weight. See “Specifications” on page 141 or measure and weigh equipment before lifting.

1. Attach chains to four lift points (two on each side of drilling unit).
2. Attach each chain securely to cross members.

IMPORTANT: Length of spreader bars should be equal to width of drilling unit.

3. Bring chains together to a central pull point.

Haul

Load

⚠WARNING Crushing weight. If load falls or moves it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICE:

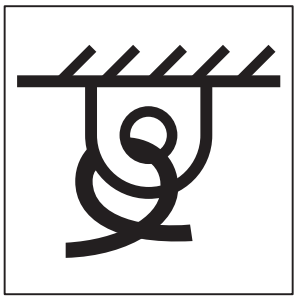
- Load and unload trailer on level ground.
- Verify that trailer wheels are blocked.
- Incorrect loading can cause trailer swaying.
- Attach trailer to vehicle before loading or unloading.
- Ten to fifteen percent of total vehicle weight (equipment plus trailer) must be on tongue to help prevent trailer sway.

1. Start drilling unit engine.
2. Move drilling unit to rear of trailer and align with ramps.
3. Slow engine to low throttle and slowly drive unit onto trailer.
4. Lower stabilizer to trailer floor.
5. Stop engine when unit is safely positioned on trailer bed.
6. Attach tiedowns to drilling unit where indicated on page 67.

Tie Down

Points

Tiedown points are identified by tiedown decals. Securing to trailer at other points is unsafe and can damage machinery.



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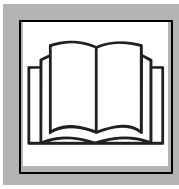
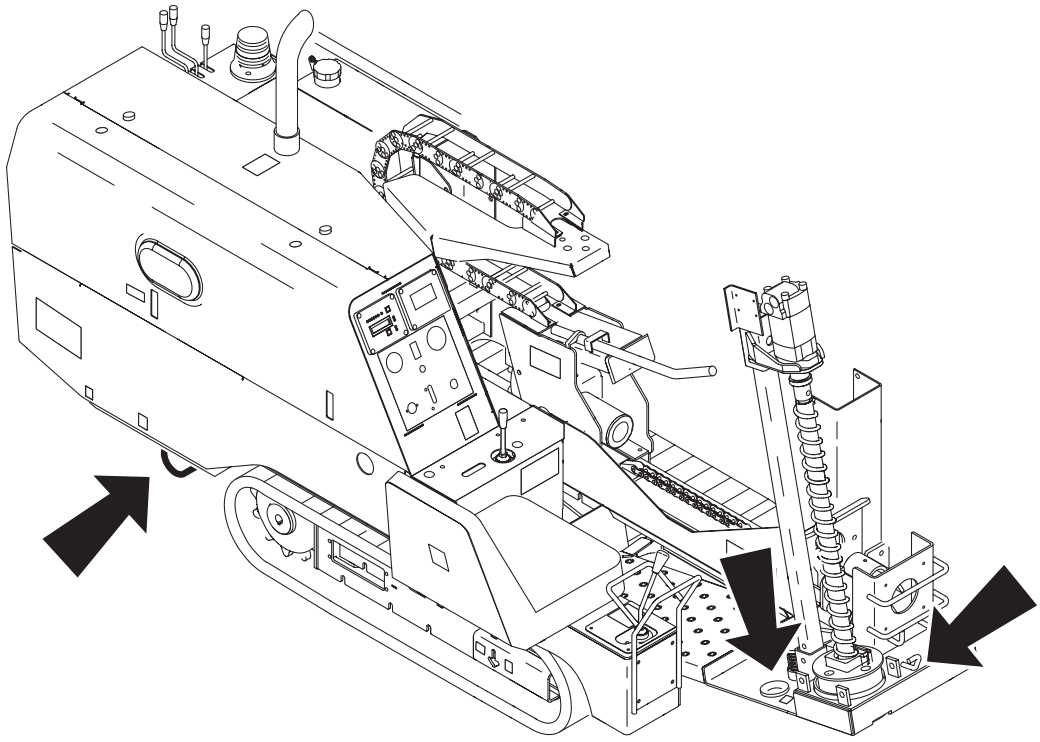
Procedure



WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

Loop tiedowns around rear tiedown points. Use D-ring or pin to trailer using hole in floor plate. Make sure tiedowns are tight before transporting.



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Unload

WARNING Crushing weight. If load falls or moves it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICE:

- Load and unload trailer on level ground.
- Ensure trailer wheels are blocked.
- Attach trailer to vehicle before loading or unloading.

1. Lower ramps.
2. Remove tiedowns.
3. Start drilling unit engine.
4. Raise stabilizer.
5. Slow engine to low throttle and slowly back unit down trailer or ramps.

Tow

Under normal conditions, drilling unit should not be towed. If unit breaks down and towing is necessary:

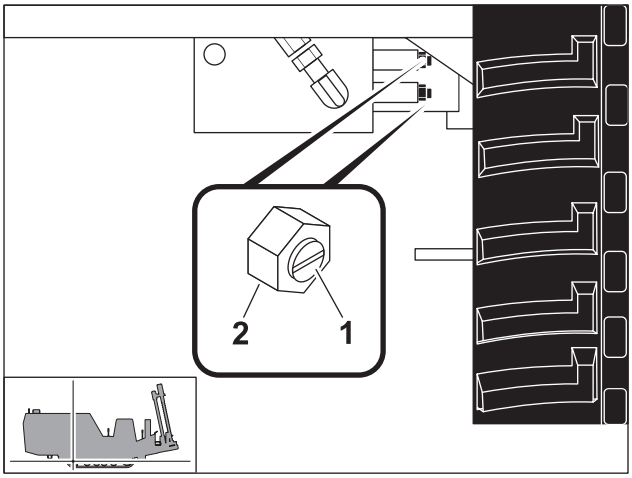
- Attach chains to indicated tow points facing towing vehicle.
- Disengage track hydraulics.
- Tow for short distances at less than 1 mph (1.6 km/h).
- Use maximum towing force of 1.5 times unit weight.

To disengage track hydraulics:

1. Loosen locknut (2).
2. Turn screw (1) on each counterbalance valve clockwise until it stops.

IMPORTANT: Be sure to count number of turns.

3. Repeat on other track.



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To engage track hydraulics:

1. Turn screw (1) on counterbalance valve exactly the same number of turns counterclockwise.
2. Tighten locknut (2).
3. Repeat on other track.

To attach chains to tow points, determine which points are facing towing vehicle.

- If **back** tow points are facing towing vehicle, loop chains through each tow point and bring them together to a central pull point.
- If **front** tow points are facing towing vehicle, loop chain through tow point and pull straight forward.

Conduct a Bore

Chapter Contents

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Start System 73

Prime Drilling Fluid Pump 73

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- Prepare Beacon Housing 75
- Attach EZ-Connect to Drill Head 75
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- Connect Drill Pipe 76
- Engage EZ-Connect . . . . . .

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- Basic Rules 79
- Procedure 79
- Drill Head Position 80

Record Bore Path 80

Surface Drill Head 81

Assemble Backream String 82

Remove Pipe 83

Remove Pullback Device 84

Position Equipment

1. Review bore plan and select drilling unit position and fluid unit position. See "Select Start and End Points" on page 47.
2. Move equipment into selected positions.

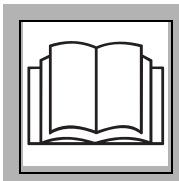
Start System

1. Start drilling unit and remote fluid unit. Allow both engines to warm up.

IMPORTANT: Ensure that mixture of drilling fluid matches drilling conditions.

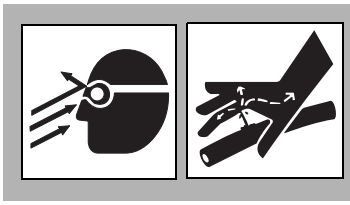
2. Enable tracker control mode if desired. See "Tracker Control" on page 99.
3. Move drilling unit throttle control until engine is at full throttle.
4. Move fluid control to desired setting to fill pipe with fluid.

Prime Drilling Fluid Pump



WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

NOTICE: Failure to prime the drilling fluid pump will cause flow fluctuations, which will make it difficult to control the washwand.

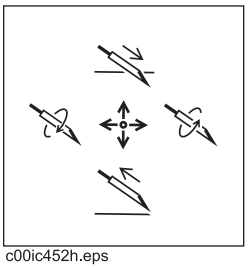


WARNING Pressurized fluid or air could pierce skin and cause injury or death. Stay away.

Prime drilling fluid pump each time tank is changed. To prime the pump:

1. Fill drilling fluid hose and connect hose to unit.
2. Operate mixing/transfer pump at full speed for 1 - 3 minutes to discharge air from system.
3. Return mixing/transfer pump to normal operating speed and continue the bore.
4. If drilling fluid pressure surges are observed, repeat step 2.

Operate Carriage Control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The thrust/rotation control has eight positions which allow the four basic functions to be combined. The chart below summarizes functions that occur when control is put at a combined position. Operator must be in seat for control to function.

Carriage Movement	Rotation Direction	
forward	clockwise (makeup)	ic1102a.eps
reverse	counterclockwise (breakout)	ic1104a.eps

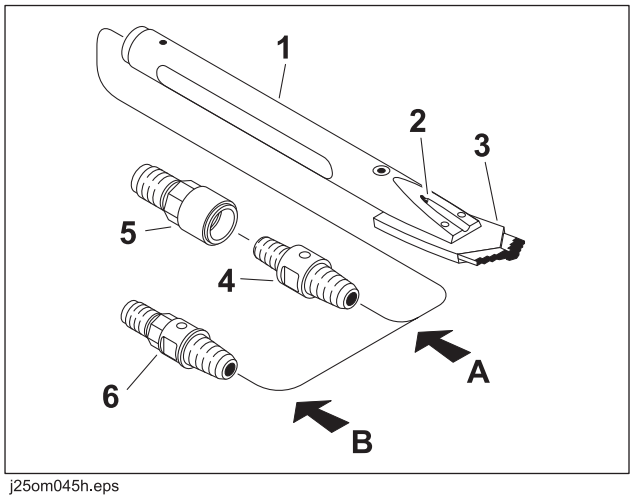
Assemble Drill String

Prepare Beacon Housing

1. Select nozzles and bit.

IMPORTANT: A variety of nozzles and bits are available to suit your particular job conditions. See "Downhole Tools" on page 102 for more information, or contact your Ditch Witch dealer.

2. Insert nozzle (2) into beacon housing.
3. Attach bit (3) to beacon housing (1).
4. Install beacon, following beacon instructions for:
   - battery replacement
   - beacon positioning
5. Install beacon housing lid. See "Beacon Housings" on page 103.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.



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Attach EZ-Connect to Drill Head

Option A

1. Apply tool joint compound to shoulders and threads and hand tighten pin-to-pin adapter (4) to beacon housing (1).
2. Use quick wrench to fully tighten joint.
3. Hand tighten EZ-Connect pin (5) to pin-to-pin adapter (4).
4. Use quick wrench to fully tighten joint.

Option B

1. Apply tool joint compound to shoulders and threads and hand tighten pin to EZ-Connect pin adapter (6).
2. Use quick wrench to fully tighten joint.

Attach Transition Sub

Use either machine torque or quick wrench to attach transition sub (2) to beacon housing (1).

Machine Torque

1. Apply tool joint compound to shoulders and threads and thread transition sub onto saver sub.
2. Align drill pipe flats of EZ-Connect box with front wrench of drill frame.
3. Start drilling unit engine.
4. Use machine power to slowly rotate spindle and transition sub onto EZ-Connect box.
5. Tighten to full machine torque.

Quick Wrench

1. Lube joints with TJC.
2. Attach quick wrench to the joint in the join position and tighten joint. See "Quick Wrench" on page 107.

Connect Drill Pipe

1. Start drilling unit engine.
2. Align transition sub in front wrench.
3. Load pipe.
4. Lubricate shoulders and threads.
5. Move carriage forward until saver sub nears male pipe thread.
6. Slowly rotate spindle clockwise. Carriage will move forward as threads screw together.
7. Slowly move carriage forward until pipe end touches end of transition sub.
8. To thread pipes together and fully torque joint, slowly rotate drill pipe until spindle stops turning.
9. Open front wrench and move carriage back.
10. Turn off engine.

Engage EZ-Connect

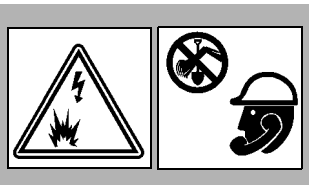
1. Apply tool joint compound to shoulders and threads and align hole in EZ-Connect collar with tapped hole in EZ-Connect box.
2. Slide collar onto octagonal barrel and push toward wrench flats.
3. Thread tool head EZ-Connect pin into EZ-Connect box until shoulders are touching.
4. Back tool head off one flat and slide collar onto pin until retainer bolt hole is visible.
5. Lube retainer bolt with tool joint compound, install, and tighten.

Drill First Pipe

DANGER Turning shaft can kill you or crush arm or leg. Stay away.

NOTICE:

- Keep everyone at least 10' (3 m) away from turning drill string.
- Push rod or pipe slowly. Forcing can bend string. Do not use bent rod or pipe.



WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

1. Turn on drilling fluid.
2. Visually check for drilling fluid flow.
3. Turn drill bit to starting position. See "Prepare Entry Point" on page 55.
4. Slowly move carriage forward. See "Prepare Entry Point" on page 55. Take care to steer to drill straight in line with drilling unit. Drill in downhole tools and 1/3 of first pipe before steering.
5. Monitor gauges.

Add Pipe

1. When joint flats are aligned with front wrench, release joystick.
2. Engage front wrench.
3. Rotate spindle clockwise slowly until wrench flats engage pipe flats.
4. Reverse rotation and slowly move carriage back as threads unscrew.

NOTICE: To prevent unnecessary load on threads, which can lead to thread wear, slowly move carriage back while unscrewing.

5. Take next pipe from pipe box and place it inline with saver sub and last pipe.
6. Lubricate shoulders and threads.
7. Lubricate the saver sub at least every five pipes or when the thread is shiny.
8. Connect pipe to saver sub.
    - Move carriage forward until saver sub nears male pipe thread.
    - Continue to lower carriage and rotate spindle until pipe screws into saver sub.
    - Move carriage forward until front end of pipe is aligned with male thread of last pipe
9. Use machine power to slowly rotate spindle and drill pipe onto male thread.
10. Tighten to full machine torque.
11. Ensure engine is at full throttle.
12. Move fluid control to desired setting to fill pipe with fluid.
13. Ensure that pipe fills and fluid pressure begins to rise.
14. Rotate spindle.
15. Slowly move carriage forward. Adjust rotation speed control according to bit size and soil conditions.
16. Monitor gauges.
17. Locate drill head with tracker at least every half-length of pipe.

Correct Direction

Correcting direction is a skill operators gain with experience and knowledge of equipment and soil conditions. These instructions cover only basic procedures. For information about specific equipment or jobsites, contact your Ditch Witch dealer.

To track progress and make corrections, one crew member locates the drill head and sends instructions to the operator. Corrections are made by tracking the drill head, comparing current position to bore plan, and steering drill head as needed.

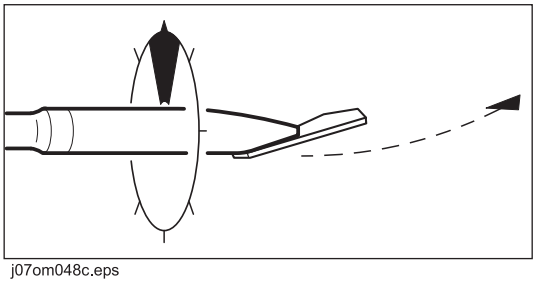
Basic Rules

- Steering ability depends on soil condition; bit, drill head, and nozzle used; roll of drill head; and distance pushed without outer rotation.
- All corrections should be made as gradually as possible. See "Recommended Bend Limits" on page 51.
- Over correcting will cause "snaking." This can damage pipe and will make drilling and pullback more difficult. Begin to straighten out of each correction as early as possible.
- Do not push an entire piece of drill pipe into ground without rotation. This can exceed bend radius and cause pipe failure.

Procedure

1. Locate drill head. Take readings available with your beacon and locating equipment such as:
    - depth
    - pitch
    - left/right information
    - temperature
    - beacon roll
2. Compare position to bore plan. Determine direction drilling should go.
3. Position drill head.
4. Push in drill pipe as needed to change direction.
5. Rotate in remaining length of drill pipe.

Drill Head Position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The drill head position is determined by reading beacon roll. Roll is displayed as a clock face position.

1. Read beacon roll.
2. Slowly rotate pipe until locator displays desired beacon roll.

To change direction:

1. Rotate pipe to clock position you intend to travel.
2. Push pipe into ground.

To move forward without changing direction:

Rotate pipe into ground.

Record Bore Path

Locate drill head every half-length of pipe. As the job is completed, record the actual data for each drill pipe. List pitch and depth of each joint and a brief description of the procedure. In addition, draw a simple sketch of the site and record depth and rough location of pullback.

The Trac Management System Plus is also available for plotting and tracking your bore path. It utilizes the 750 Tracker, 750 Display, a tracking beacon, and special software. The display can store jobs in its memory or the system can be run in the field using a laptop computer equipped with the Windows® 95 or higher operating system. See your Ditch Witch dealer for details.

Surface Drill Head

DANGER Moving tools will injure or kill. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

1. Guide drill head to target pit or up through surface. Make all bends gradual. See "Recommended Bend Limits" on page 51.
2. Clean area around exit point.
3. If using tracker control mode, tracker operator turns off tracker to disable drilling unit thrust/pullback and rotation hydraulics. Tracker operator waits for green light to enter pit and change tools.

   If not using tracker control mode, tracker operator signals to drilling unit operator to stop engine before changing downhole tools.
4. Turn fluid flow control to off position as soon as drill head emerges.
5. Clean drill head especially around threads.
6. Disconnect EZ-Connect joint or use quick wrench to remove drill head. Keep threads clean. See "Quick Wrench" on page 107.

Assemble Backream String

DANGER Turning shaft will kill you or crush arm or leg. Stay away.

NOTICE: Keep everyone away from material being installed.

DANGER Moving tools will injure or kill. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

NOTICE: Continue to use strike system during backreaming.

1. Select backreaming devices. See "Backreamers" on page 104.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow. See "Backream Fluid Requirements" on page 105 and "Nozzles" on page 102.
3. Attach backreamer to backream beacon housing if tracking backream.
4. Install beacon, following beacon instructions for:
   - battery replacement
   - beacon positioning
5. Install beacon housing lid. See "Beacon Housings" on page 103.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.
8. Connect EZ-Connect joint or use quick wrench to attach backreamer/beacon housing assembly to transition sub. See "Quick Wrench" on page 107.
9. Attach swivel and additional pullback devices or product to end of backreamer/beacon housing assembly.

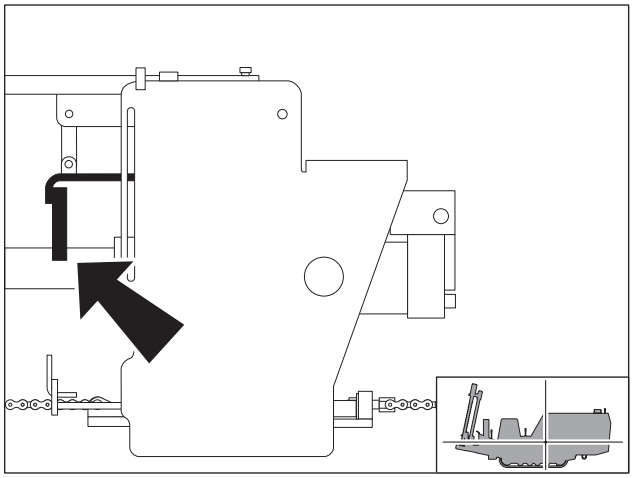
Remove Pipe

1. When pipe joint is between front wrench and pipe wiper, release joystick.
2. Engage front wrench.
3. Rotate spindle clockwise until wrench flats engage into pipe flats.
4. Rotate counterclockwise until upper joint breaks.

   If joint does not break at spindle, use auxiliary wrench (shown).

   - Engage auxiliary wrench.
   - Rotate spindle counterclockwise until wrench flats engage into pipe flats.
   - Turn spindle counterclockwise until joint breaks.
   - Disengage auxiliary wrench.

5. Engage breakout wrench.
6. Rotate spindle clockwise until wrench flats align with pipe flats.



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Remove Pullback Device

The pullback device can be removed when the last pipe is on the frame. It can also be removed when a target pit along the bore path has been reached. Remaining pipe is then pulled back and removed.

⚠ DANGER Moving tools will injure or kill. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

1. Turn off drilling fluid.
2. Move drilling unit throttle control until engine is at low throttle.
3. Turn drilling unit engine off.
4. Use tracker control to verify that unit is turned off.
5. Clean pullback device.
6. Use quick wrench to remove pullback device. See "Quick Wrench" on page 107.

Systems and Equipment

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Anchor System

WARNING Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

NOTICE:

- Drive anchor properly before drilling.
- Wear high-top protective boots with legs of pants completely tucked inside.
- Wear protective gloves.
- If you are not driving anchor to full depth, drive optional ground rod into soil away from drilling unit and connect ground rod to drilling unit.

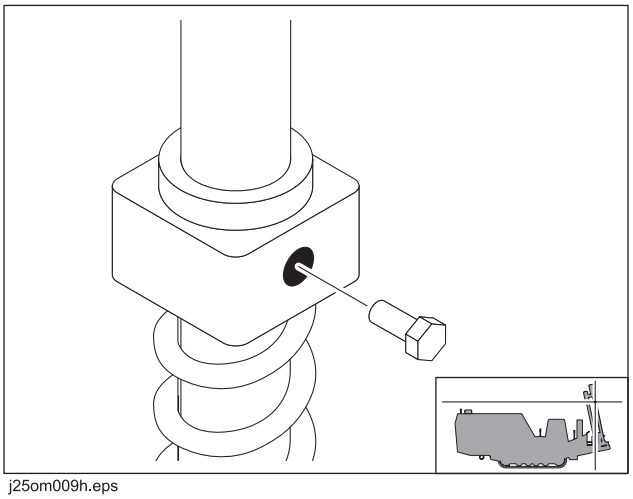
DANGER Turning shaft can kill you or crush arm or leg. Stay away.

NOTICE: Do not replace anchor collar bolt with one longer than original. Clothing could catch on turning shaft.

Drive Anchor

IMPORTANT: Carefully time anchor rotation with anchor movement. Properly driven anchor should not auger up soil.

1. Use anchor control to drive anchor into ground.
2. Anchor is set when cap (1) rests firmly on centering tube (2).



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Remove Anchor

Use anchor control to slowly remove anchor shaft from ground.

Electric Strike System

Any time you drill in an electric jobsite, electric strike system must be properly set up, tested, and used. You must wear protective boots and gloves meeting the following standards:

- Boots must have high tops and meet the electric hazard protection requirements of ANSI Z-41, 1991, when tested at 14,000 volts. Tuck legs of pants completely inside boots.
- Gloves must have 17,000 AC maximum use voltage, according to ASTM specification D120-87.

If working around higher voltage, use gloves and boots with appropriately higher ratings.

NOTICE: The strike system does not prevent electric strikes or detect strikes before they occur. **If alarms are activated, a strike has already occurred** and equipment is electrified.

Read and follow "Electric Jobsite Precautions" on page 49. Review safety procedures before each job.

FCC Statement

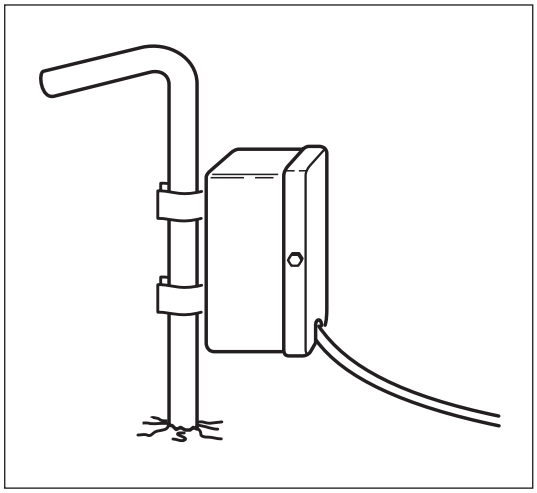
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The Electric Strike System has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, can cause harmful interference to radio communications. Operation of this equipment in a residential area could cause harmful interference which the user will be required to correct at his own expense.

Changes or modifications not expressly approved in writing by The Charles Machine Works, Inc. may void the user's authority to operate this equipment.

Assemble Voltage Detector

1. Drive voltage stake into ground at least 6' (2 m) away from any part of system.
2. Clip voltage limiter to voltage stake.



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Test Strike System

If system fails any part of this test, see "Troubleshoot Strike System" on page 90 on the following page. Do not drill until test is completed successfully.

1. Turn on drilling unit.
2. ESID control module will perform internal tests which check everything but alarms and strobe.
3. If green OK indicator and electrical power supply indicator lights remain on, press self test button to perform total test of strike system. During this test:
   - All lights should glow.
   - Alphanumeric readout should display numbers.
   - Alarms and strobes on all connected units should sound.
4. If this test is successful, OK indicator and electrical power supply indicator lights will remain on.
5. Use Electric Strike Simulator to test voltage and current sensors. See page 92.

Troubleshoot Strike System

When strike system detects a problem, an error code will be displayed. Anytime this happens, press self test button to retest. If error code is still displayed and does not appear in this chart, have control module checked or replaced.

Other problem situations and their possible causes and solutions are listed in the chart below.

Problem	Possible cause	Possible solution
No lights or readings showing after drilling unit key has been on at least one minute	Problems in startup	Push self test button. If problem goes away, retest strike system
	No power to strike system control module	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that cable from drilling unit carries more than 10V
	Defective control module	Have control module checked or replaced
Screen is blank	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10V
	Defective control module	Have control module checked or replaced
Information on screen is visible during self test but not after test is complete	LCD contrast is not set properly	Contact your Ditch Witch dealer to adjust contrast
OK indicator is on, but electrical power supply indicator is off	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10V
	Defective control module	Have control module checked or replaced
Electrical power supply indicator is on, but OK indicator is off	Problem detected during test	Check for error code and have control module checked or replaced
	Defective control module	Have control module checked or replaced

Problem	Possible cause	Possible solution
Strobe light on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective strobe light	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Alarm on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective alarm	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Strobe light and alarm on drilling unit do not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective control module	Have control module checked or replaced
EC2 code displays and current problem indicator is on	Improper connections with control module	Check cable connections on control module and current transformer
	Defective current transformer	1. Disconnect current transformer. 2. Check for 20-40 ohms from pin 1 to pin 4, 20-40 ohms from pin 1 to pin 2, and less than 1 ohm from pin 2 to pin 4.
	Defective current transformer cable	1. Disconnect cable from transformer and control module. 2. Check continuity of cable. 3. If continuity is zero or cable is damaged, replace.
	Defective control module	Have control module checked or replaced
EV1 code displays and voltage problem indicator is on	Improper connection of voltage limiter to ground stake	Check voltage limiter connection to ground stake and verify that ground stake is driven into the ground
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

Problem	Possible cause	Possible solution
EV2 code displays and voltage problem indicator is on	Improper connections with control module	Check cable connection on control module
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

Use Electric Strike Simulator

Use the Electric Strike Simulator (p/n 259-506) to test voltage and current sensors on ESID. If readings are less than indicated here, replace 9V battery in simulator and retest.

Current Test

To test for current at normal levels:

1. Thread one lead wire through current transformer.
2. Clip ends of lead wires together to make one loop.
3. Move simulator switch to "current" and press test button.
4. Watch screen and lights above display on strike system.
    - Three or four lights should turn on.
    - Current "A" should show 30-50% in display.

To test for current at strike levels:

1. Put two or three loops through current transformer.
2. Follow steps above to test.
3. Display should show the following:
   - All lights should turn on.
   - Alarm and strobe should turn on.

   With two loops,
   - Current "A" should be 80-110%.
   - Strike indication might go on and off.

   With three loops,
   - Current should be 130-160%.
   - Strike indication should be continuous.

Voltage Test

1. Place voltage limiter on something insulated from ground and drilling unit (such as dry board or tire), but near frame of drilling unit.
2. Clip one lead to frame.
3. Clip other lead to one voltage limiter mount.
4. Move simulator switch to "voltage" and press test button.
5. Watch screen and lights above display on strike system.
   - All lights should turn on.
   - Alarm and strobe should turn on.
   - Voltage "V" should show 90-110%.

It is normal for simulator voltage levels to drift below strike level. When this happens, light in triangle should go off and alarm and strobe should stop working. If the level drifts above strike level again, light, alarm, and strobe should be turned on again.

Drilling Fluid

For productive drilling and equipment protection, use these recommended Baroid® products, available from your Ditch Witch dealer.

- Soda ash
- Quik-Gel™ dry powder bentonite (p/n 259-804)
- E-Z Mud™ liquid polymer (p/n 259-805)
- Liqui-Trol™ liquid polymer suspension (p/n 259-808)
- Quik-Trol™ dry powder polymer (p/n 259-809)
- Bore-Gel™ drilling fluid (p/n 259-807)
- Con-Det™ water-soluble cleaning solution (p/n 259-810)

Guidelines

Match drilling fluid to soil type. This chart is meant as a guideline only. See your local Ditch Witch dealer for soil conditions and drilling fluid recommendations for your area. Also see our interactive Drilling Fluid Formulator at **www.ditchwitch.com**.

Soil type	Drilling fluid recommendation
smooth, flowing sand	bentonite or Bore-Gel + medium chain polymer
coarse sand or light soil	bentonite or Bore-Gel
heavy clay	long chain polymer + Con-Det
swelling clay	long chain polymer + Con-Det
rock	Bore-Gel

Polymer

This drilling fluid additive provides excellent lubrication and increases viscosity in average soils and heavy clay. In swelling clay, polymer can reduce swelling that traps pipe in the bore.

There are two types of polymer:

- long chain such as Baroid EZ-Mud
- medium chain such as Baroid Quik-Trol

Bentonite

Bentonite is a dry powder. When properly mixed with water, it forms a thin cake on bore walls, lubricating the bore, keeping it open, and holding fluid in the bore.

Some things to remember when mixing bentonite:

- Use clean water free of salt, calcium, or excessive chlorine.
- Use water with pH level between 9 and 10.
- Use water with hardness of less than 120 ppm.
- Do not use bentonite containing sand.
- Mix bentonite thoroughly or it will settle in tank.
- Do not mix bentonite to a funnel viscosity of over 50.

For information on measuring funnel viscosity, see "Funnel Viscosity" on page 98.

Mixtures

Bentonite does not mix well in water containing polymer. To use both, mix bentonite first, then add polymer. When adding other products follow the order listed below.

NOTICE:

- If chemicals are added in the wrong order, they will not mix properly and will form clumps.
- If tank contains bentonite/polymer mix and more drilling fluid is needed, completely empty tank and start with fresh water before mixing another batch.

General mixing order:

1. Soda ash
2. Bentonite
3. Polymer
4. Con-Det

Bore-Gel contains premixed bentonite, polymer, and soda ash. Use approximately 15 lb/100 gal (7 kg/380 L) in normal drilling conditions, up to 45 lb/100 gal (21 kg/380 L) in sand or gravel and up to 50 lb/100 gal (23 kg/380 L) in rock.

Basic Fluid Recipes

Soil type	Mixture/100 gal (378 L) of water	Notes
fine sand	35 lb (16 kg) Bore-Gel	
coarse sand	35 lb (16 kg) Bore-Gel .5 lb (225 g) No-Sag	Add .5 lb (225 g) of Quik-Trol for additional filtrate control
fine sand below water table	40 lb (18 kg) Bore-Gel .75 lb (340 g) Quik-Trol	Add .5 - 1 gal (2-4 L) of Dinomul in high torque situations
coarse sand below water table	40 lb (18 kg) Bore-Gel .75 lb (340 g) Quik-Trol .75 lb (340 g) No-Sag	Add .5 - 1 gal (2-4 L) of Dinomul in high torque situations
gravel	50 lb (23 kg) Bore-Gel .75 lb (340 g) Quik-Trol .75 lb (340 g) No-Sag	Add .5 lb (225 g) of Barolift to reduce loss of returns
cobble	50 lb (23 kg) Bore-Gel .75 lb (340 g) Quik-Trol .75 lb (340 g) No-Sag	Add .5 lb (225 g) of Barolift to reduce loss of returns
sand, gravel, clay or shale	35 - 40 lb (16-18 kg) Bore-Gel .5 pt (235 mL) EZ-Mud .5 gal (2 L) Con-Det	Vary mixture according to percentage of sand and clay
clay	.5 lb (225 g) Poly Bore .5 gal (2 L) Con-Det	Flow rate should be 3-5 parts fluid to 1 part soil. May use .25 - .5 gal (1-2 L) of Penetrol instead of Con-Det
swelling/sticky clay	.75 - 1 lb (340-450 g) Poly Bore .5 - 1 gal (2-4 L) Con-Det	Flow rate should be 3-5 parts fluid to 1 part soil. May use .25 - .5 gal (1-2 L) of Penetrol instead of Con-Det
solid rock (shale)	40 lb (18 kg) Bore-Gel	Use .5 pt (235 mL) of No Sag for large diameter or longer bores
solid rock (other than shale)	40 - 50 lb (18-23 kg) Bore-Gel	Use .5 pt (235 mL) of EZ-Mud in reactive shales
rock/clay mixture	40 - 50 lb (18-23 kg) Bore-Gel .5 pt (235 mL) EZ-Mud	
rock/sand mixture	40 - 50 lb (18-23 kg) Bore-Gel	Use .5 pt (235 mL) of No Sag for large diameter or longer bores
fractured rock	50 lb (23 kg) Bore-Gel .5 - 1lb (225-450 g) No-Sag	Use .5 lb (225 g) of Barolift to reduce fluid loss to formation

Drilling Fluid Requirements

1. Determine drilling conditions and choose appropriate drilling fluid mix.
2. Estimate amount of supplies needed and check availability.
   - Drilling fluid
   - Water supply. If more water than can be carried with the unit will be needed, arrange to transport additional water.
   - Bentonite and/or polymer
3. Check water quality.
   - Use meter or pH test strips to test pH of water. If pH is below 9.0, add 1 lb (454 g) soda ash per tank. Test and repeat until pH is between 9 and 10.
   - Check water hardness using hardness test strips. Treat with soda ash if hardness exceeds 125 ppm.

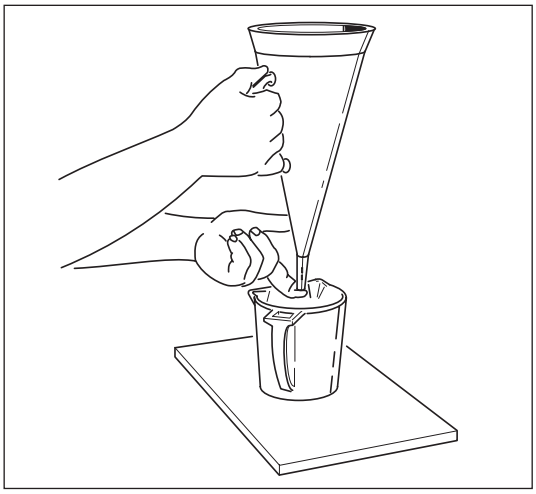
Funnel Viscosity

Viscosity is the measure of internal resistance of a fluid to flow; the greater the resistance, the higher the viscosity. Viscosity of drilling fluids must be controlled.

To determine viscosity, you will need a Marsh funnel (p/n 259-267) and a measuring cup, available from your Ditch Witch dealer.

IMPORTANT: Make sure Marsh funnel is clean and free of obstruction and that you have a stopwatch available for timing the viscosity.

1. Using wash hose and a clean container, take a fresh sample of drilling fluid. The sample must be at least 1.5 qt (1.4 L).
2. With finger over bottom of funnel, fill with fluid from the container through the screen until fluid reaches the bottom of the screen.
3. Move funnel over 1 qt (.95 L) container.
4. Remove finger from bottom of funnel and use the stopwatch to count the number of seconds it takes for 1 qt (.95 L) of fluid to pass through the funnel. The number of seconds is the viscosity.
5. Thoroughly rinse measuring cup and Marsh funnel.



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Tracker Control

Overview

WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

This mode allows the 750 Tracker operator to disable hydraulic power to drilling unit thrust and rotation.

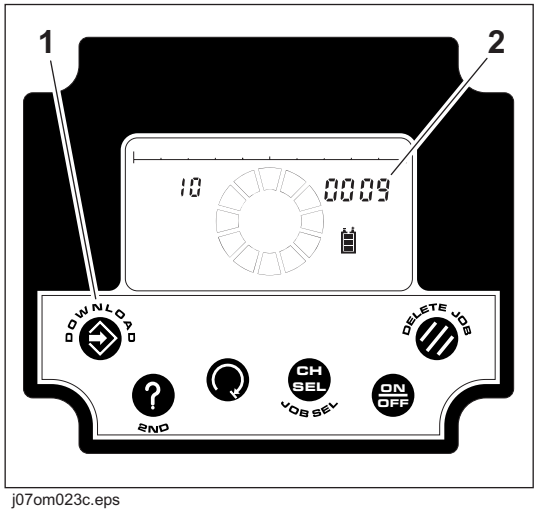
NOTICE: This mode does not disable thrust and rotation immediately. Functions are disabled within 16 seconds.

Use tracker control any time you change downhole tools or during other times when the drill string is exposed. Tracker control works by stopping communication between the tracker and the display. When this happens, the green tracker control light on the drilling unit comes on and thrust and rotation are disabled.

Operation

Enable Thrust and Rotation

1. Start drilling unit.
2. Turn off 750 Display.
3. Press and hold DOWNLOAD (1) while turning on 750 Display until a four-digit code (2) appears.



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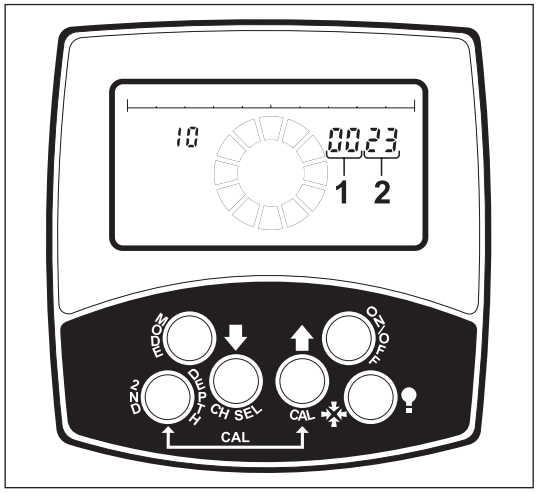
4. Turn on 750 Tracker and check four-digit code.

   If codes on tracker and display match, thrust and rotation hydraulics on the drilling unit are enabled.

   If codes on tracker and display do not match, adjust tracker code:

   - Press and hold fore/aft/left/right button while making the following adjustments.
   - Use ON/OFF to advance first two digits (1). Use DEPTH to lower first two digits.
   - Use up arrow to advance last two digits (2). Use down arrow to lower last two digits.
   - Press and hold each button to advance or lower value quickly.
   - To start sending code from the tracker to the display, press and hold fore/aft/left/right button and press MODE. Thrust and rotation hydraulics on the drilling unit are now enabled.



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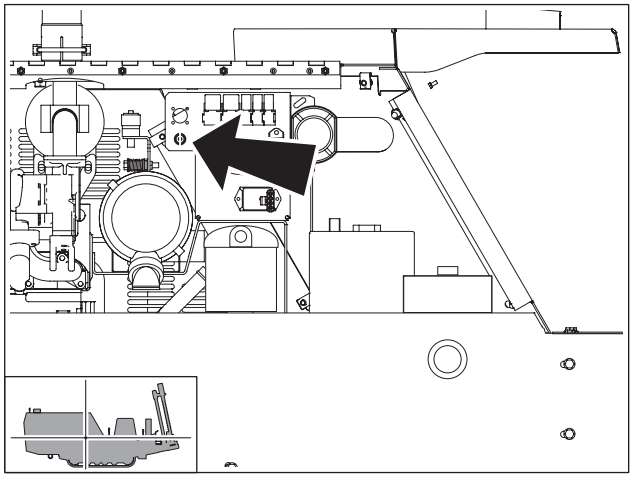
Troubleshooting Tip: If thrust and rotation are not enabled:

- Check whether the green tracker control light located on carriage is on. If it is, communication has probably stopped between tracker and display, or tracker is set to incorrect code.
- If communication cannot be restored, install tracker control key (shown) in drilling unit. Green tracker control light located on carriage will go off. Thrust and rotation will function.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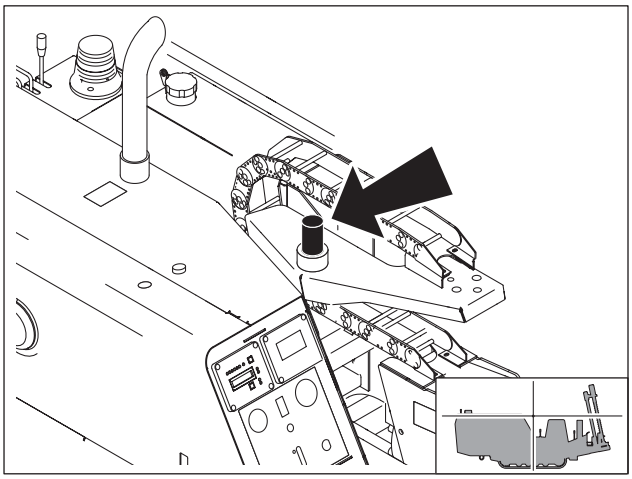
5. Remove tracker control key (shown). Keep in tracker operator's possession.
6. Drill and track bore.

Disable Thrust and Rotation

1. When drill head enters target pit or exits the ground, turn off tracker.

   After 8-16 seconds, green tracker control light (shown), located on drilling unit carriage, will come on. Hydraulic power to thrust and rotation will be disabled.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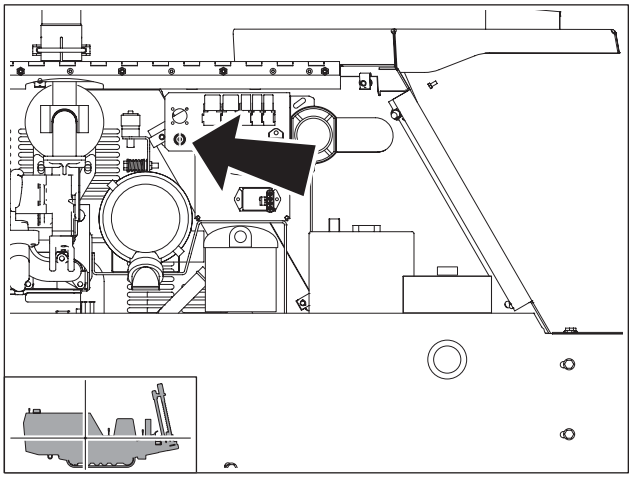
IMPORTANT: Tracker operator cannot disable thrust and rotation from tracker if tracker control key (shown) is installed in drilling unit and turned to the disable position. See "Tracker control key" on page 29 for more information.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NOTICE: If you are not using tracker control, turn off drilling unit before changing downhole tools.

2. Change downhole tools.
3. **If you are tracking backreamer's path**, turn on tracker and enable code transmission. After 8-16 seconds, green tracker control light on drilling unit carriage will go off and thrust and rotation will function.

   If you are not tracking backreamer's path, install tracker control key (shown) on drilling unit. Green tracker control light on drilling unit carriage will go off and thrust and rotation will function.

Downhole Tools

Nozzles

Nozzles control fluid flow from the pipe to the bore. Select nozzles that will supply **at least** the amount of fluid per minute needed for the flow and pressure you will be using. A nozzle that will supply more fluid per minute is recommended. See your Ditch Witch dealer for nozzle recommendations.

Bits

Selection

These charts are meant as a guideline only. No one bit works well in all conditions. See your Ditch Witch dealer for soil conditions and bit recommendations for your area. Also see our interactive Downhole Tool Selector at **www.ditchwitch.com**.

- 1 = best
- 2 = good
- 3 = fair
- 4 = not recommended

Bit	Sandy Soil	Soft Soil	Medium Soil	Hard Soil	Rocky Soil	Soft Rock	Hard Rock
Sand bit	1	2	4	4	4	4	4
Durabit	2	2	1	1	4	4	4
Tuff bit	2	1	1	1	2	3	4
Steep Taper Tuff bit	4	3	2	1	1	2	4
Barracuda bit	2	1	1	2	3	4	4
Steep Taper bit	4	3	2	1	1	2	4
Hard Surface bit	2	1	2	3	4	4	4
Glacier bit	4	4	4	3	1	2	4
Rhino bit	4	4	3	3	1	1	3
Jetting assembly	4	4	3	2	1	2	3
Rockmaster	4	4	3	2	1	1	1
Talon Rock bit	4	3	2	1	1	1	4

Soil	Description
sandy soil	sugar sand, blow sand, or other soils where sand is the predominant component
soft soil	sandy loam
medium soil	loams, loamy clays
hard soil	packed clays, gumbo, all compacted soils
rocky soil	chunk rock, glacial till, cobble, rip rap, gravel
soft rock	soft limestone, sandstone, shale, coral, caliche
hard rock	granite, schist, marble, hard limestone

Installation

Remove all paint from mating surfaces before attaching any bit to housing. Install screws (p/n 107-277) and tighten bolts to 120 ft•lb (163 N•m).

Beacon Housings

Beacon Installation

To ensure beacon is installed correctly in rock housing, place battery end of beacon away from bit end of housing.

Backreamers

A backreamer enlarges the hole as pipe is pulled back through the bore. No one backreamer works well in all conditions. These charts are meant as a guideline only. See your local Ditch Witch dealer for soil conditions and backreamer recommendations for your area. Also see our interactive Downhole Tool Selector at **www.ditchwitch.com**.

- 1 = best
- 2 = good
- 3 = fair
- 4 = not recommended

Backreamer	Sandy Soil	Soft Soil	Medium Soil	Hard Soil	Rocky Soil	Soft Rock	Hard Rock
Beavertail	3	1	1	1	3	4	4
Three Wing	4	3	3	2	1	1	4
Water Wing	4	3	2	1	2	2	4
Compact Fluted	1	1	2	2	2	3	4
Kodiak	4	3	3	2	1	2	4
Rhino Rock	4	4	4	4	3	2	1
Rockmaster	4	4	4	4	3	1	1
Compaction Cone	1	2	3	4	4	4	4
HC Hard Condition	4	3	2	1	1	4	4
ST Saw Tooth	2	2	1	2	2	3	4
MX Mixer	2	2	3	4	4	4	4
CT Cutter	3	2	1	2	3	4	4
EX Expander	1	2	3	4	4	4	4
Fluted Cone	1	1	2	2	2	3	4

IMPORTANT: For soil definitions, see the chart on the previous page.

Backream Fluid Requirements

Backreaming is only successful when enough fluid reaches the bore. The amount of fluid needed depends on size of bore and soil condition.

Follow these steps to find the **minimum** amount of fluid needed in perfect conditions.

IMPORTANT: Use more fluid than recommended or the backream might be dry and unsuccessful.

Instructions	Example
1. Find amount of fluid needed for your size of backreamer. See the table on the next page.	**U.S.** A 6" backreamer requires at least 1.47 gal/ft.
	Metric A 152-mm backreamer requires at least 18.24 L/m.
2. Multiply this number by distance per minute you plan to backream. The answer is an estimate of amount of fluid you will need for each minute of backreaming.	**U.S.** 1.5 gal x 2 ft/min = 3 gal for each minute of backreaming.
	Metric 18 L x .5 m/min = 9 L for each minute of backreaming

IMPORTANT: After you have determined how much fluid you will need, see your Ditch Witch dealer for nozzle recommendations.

Backream Fluid Requirements

Backreamer/product diameter		Gal/ft	L/m	Backreamer/product diameter		Gal/ft	L/m
.5 in	13 mm	0.01	0.13	13.5 in	343 mm	7.44	92.35
1 in	25 mm	0.04	0.51	14 in	356 mm	8.00	99.31
1.5 in	38 mm	0.09	1.14	14.5 in	368 mm	8.58	106.54
2 in	51 mm	0.16	2.03	15 in	381 mm	9.18	114.01
2.5 in	64 mm	0.25	3.17	15.5 in	394 mm	9.80	121.74
3 in	76 mm	0.37	4.56	16 in	406 mm	10.44	129.72
3.5 in	89 mm	0.5	6.21	16.5 in	419 mm	11.11	137.95
4 in	102 mm	0.65	8.11	17 in	432 mm	11.79	146.44
4.5 in	114 mm	0.83	10.26	17.5 in	445 mm	12.49	155.18
5 in	127 mm	1.02	12.67	18 in	457 mm	13.22	164.17
5.5 in	139 mm	1.23	15.33	18.5 in	470 mm	13.96	173.42
6 in	152 mm	1.47	18.24	19 in	483 mm	14.73	182.92
6.5 in	165 mm	1.72	21.41	19.5 in	495 mm	15.51	192.68
7 in	178 mm	2.00	24.83	20 in	508 mm	16.32	202.68
7.5 in	190 mm	2.29	28.50	20.5 in	521 mm	17.15	212.94
8 in	203 mm	2.61	32.43	21 in	533 mm	17.99	223.46
8.5 in	216 mm	2.95	36.61	21.5 in	546 mm	18.86	234.23
9 in	229 mm	3.30	41.04	22 in	559 mm	19.75	245.25
9.5 in	241 mm	3.68	45.73	22.5 in	572 mm	20.65	256.52
10 in	254 mm	4.08	50.67	23 in	584 mm	21.58	268.05
10.5 in	267 mm	4.50	55.86	23.5 in	597 mm	22.53	279.83
11 in	289 mm	4.94	61.31	24 in	610 mm	23.50	291.86
11.5 in	292 mm	5.40	67.01	24.5 in	622 mm	24.49	304.15
12 in	305 mm	5.88	72.97	25 in	635 mm	25.50	316.69
12.5 in	318 mm	6.37	79.17	25.5 in	648 mm	26.53	329.49
13 in	330 mm	6.90	85.63	26 in	660 mm	27.58	342.53

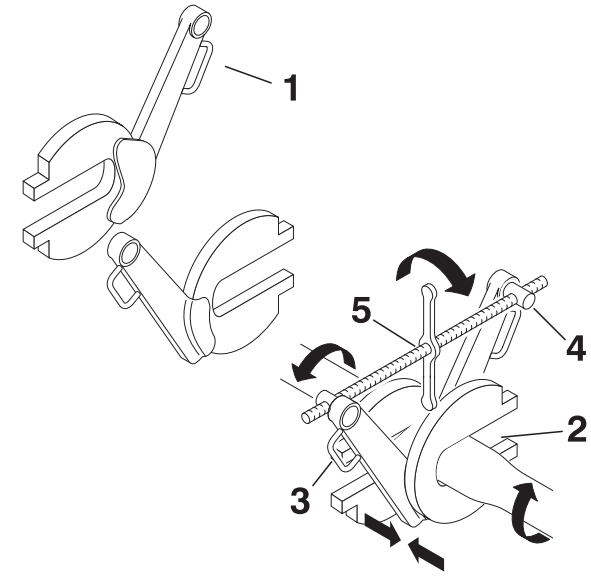
Quick Wrench

To attach or remove downhole tools, use quick wrench to join or break the joint.

DANGER Moving tools will injure or kill. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

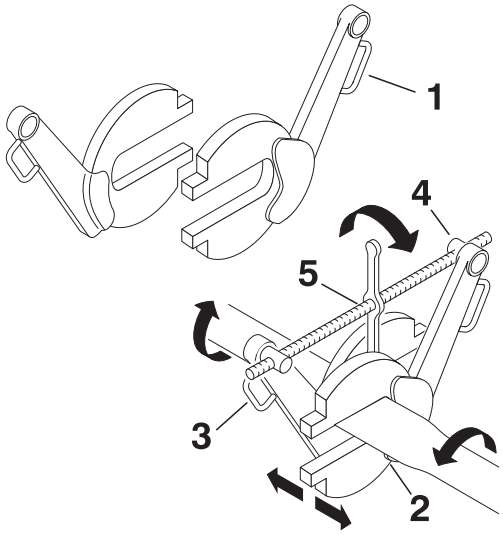
IMPORTANT: Apply TJC to threads and hand-tighten joint before attaching quick wrench components to tighten joint.

Attach quick wrench in either the join or break position.



QuickWrench_JoinBreak.eps

Join

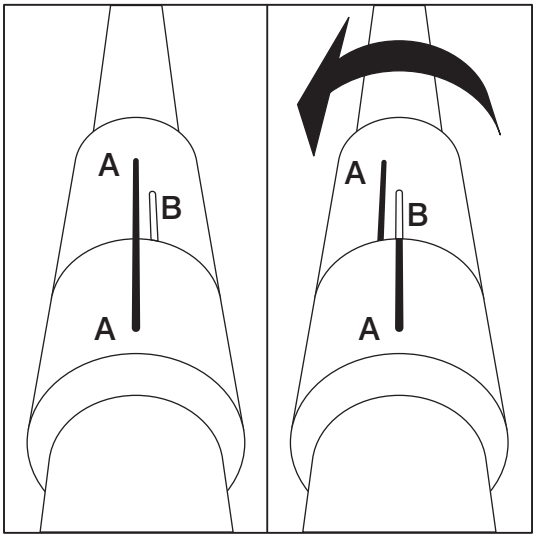


Break

- Place jaws (1) on wrench flats on both sides of joint.
- Pin handles (3) to wrench jaws. Be sure handles are both up.
- Attach pivot nuts (4) to wrench handles so that screw drive handle (5) is over joint.

To Join

1. Scribe straight line across joint on both sides of separating line (A).
2. Scribe second line (B) on moveable side of joint in the opposite direction of tightening action .25" (6 mm) away from first line.
3. Turn handle until second line (B) meets first (A).
4. Turn handle opposite direction two turns to relieve pressure.
5. Remove quick wrench components.



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To Break

1. Turn handle until joint is broken.
2. Turn handle opposite direction two turns to relieve pressure.
3. Remove quick wrench components.

Drill Pipe

Perform Regular Drill Pipe Care

Precondition New Pipe

Repeat this procedure **three times** for each piece of pipe before it is used the first time:

1. **Hand-lubricate** entire surface of threads and shoulders of both ends of pipe with copper base tool joint compound. See page 120 for correct lubricant.
2. Join pipe and tighten joint.
3. Break joint.
4. Move pipe back to box.

NOTICE: Failure to follow this procedure could result in fused joints. Pipe will be damaged or destroyed.

Lubricate Joints Before Each Use

Lubricate threads and shoulders of male joints with copper base tool joint compound. This prevents rust and reduces wear on shoulders and threads. See page 120 for correct lubricant.

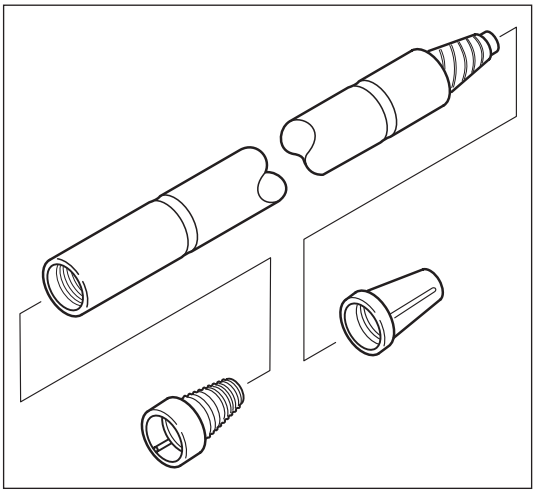
Clean the Threads

Clean the threads as needed with high-pressure water and detergent.

NOTICE: Do not use gasoline or other petroleum-based solvents. This prevents tool joint compound from sticking to the joints and will reduce thread life.

Use Caps and Plugs

Before transporting in dusty conditions or prolonged storage, install caps and plugs to male and female ends of pipe and to saver sub.



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Replace Worn Saver Sub

Because each pipe comes in contact with the saver sub, check saver sub regularly for wear. Replace it when it is worn, or it will damage your drill pipe. See page 138 for replacement procedure.

Precondition a new saver sub the same way you do new pipe. See “Precondition New Pipe” on page 109.

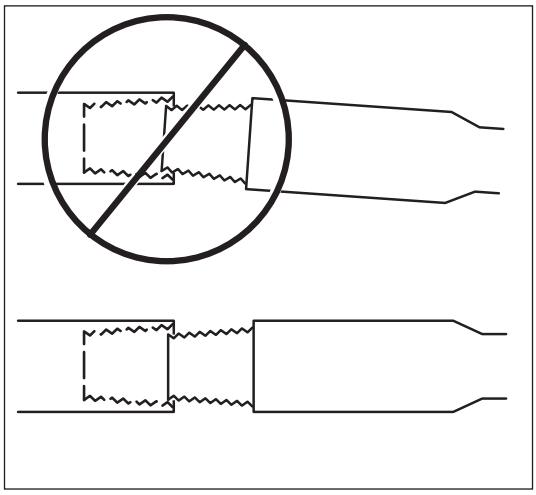
Rotate Pipe Order

Because the lead drill pipe is in the ground longer, it is subjected to higher shock loads and experiences more wear. To help spread this wear evenly over all pipe, move the lead pipe from the previous job out of the first position. See “Rotate Pipe Order” on page 110.

Use Drill Pipe Correctly

Align the Joints

Always carefully align the male and female ends of pipe before screwing them together. Poor alignment can damage the threads and destroy the usefulness of the joint.



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Make Up and Break Out Joints Correctly

- **Make up and break out joints slowly.** Do not ram pipes together during makeup or force them apart during breakout. Carefully time rotation with carriage travel speed, and always connect and disconnect joints slowly and deliberately. This will help prevent thread crossing, galling, and shoulder swelling.
- **Torque joints fully.** Once the joint is connected and the shoulder faces are touching, torque them to full machine torque. Improperly torqued joints will damage the shoulder faces and threads, and will cause joints to leak or break while drilling or backreaming.

Do not Overwork the Pipe

Never exceed the bend radius for your pipe. See "Recommended Bend Limits" on page 51. Do not oversteer.

NOTICE: Bending pipe more sharply than recommended will damage pipe and cause failure.

Complete the Job

Chapter Contents

Antifreeze Drilling Unit 114

- Add Antifreeze 114
- Reclaim Antifreeze 114

Rinse Equipment 115

Disconnect 115

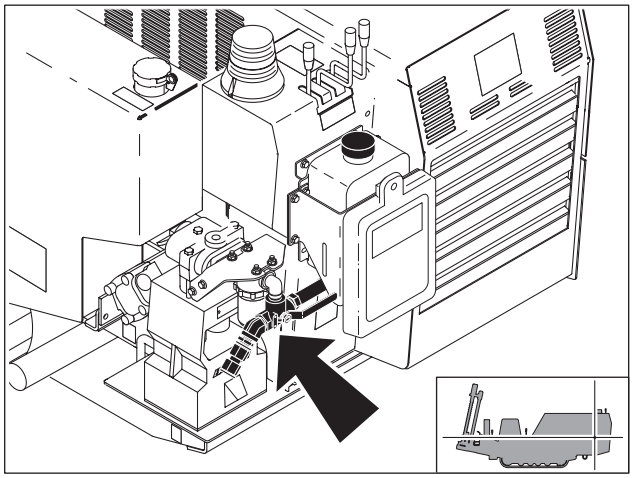
Stow Tools 115

Antifreeze Drilling Unit

Your drilling unit can be left overnight in freezing conditions by circulating a polyproplyene-based antifreeze (p/n 265-644) through optional antifreeze system before shutdown.

Add Antifreeze

1. Fill antifreeze tank with 1 gal (4 L) of approved antifreeze.
2. Move carriage to front of drill frame.
3. Position 1-gal (4-L) bucket under spindle.
4. Install plug at quick coupler for drilling fluid pump (shown).
5. Open valve between antifreeze tank and head of drilling fluid pump.
6. Turn drilling fluid control fully clockwise to off position.
7. Start unit and set throttle to slow position.
8. Slowly turn drilling fluid control counterclockwise to start fluid flow.



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9. Run drilling fluid pump until antifreeze comes out of spindle.
10. Turn drilling fluid control fully clockwise to stop flow.

Reclaim Antifreeze

1. Connect remote fluid system. See page 89.
2. Turn on remote fluid system engine.
3. Start drilling unit and run at low throttle.
4. Move carriage to front of drill frame.
5. Position 1-gal (4-L) bucket under spindle.
6. Turn drilling fluid pump on low speed.
7. Turn drilling fluid pump off when drilling fluid comes out of spindle.
8. Pour antifreeze into tank.

IMPORTANT: Antifreeze can be removed from antifreeze tank and disposed of properly or it can be reused until it is too diluted with drilling fluid to protect against freezing.

Rinse Equipment

Spray water onto equipment to remove dirt and mud. Some pressure might be needed to remove dried mud from wrench area.

NOTICE: Do not spray water onto operator's console. Electrical components could be damaged. Wipe down instead.

Disconnect

Disconnect and store the following hoses and cables (if used):

- electric strike system voltage stake
- fluid hose

Stow Tools

Make sure all quick wrenches, bits, pullback devices, and other tools are loaded on trailer.

Service

Chapter Contents

Service Precautions 118

Recommended Lubricants/Service Key 120

10 Hour 122

50 Hour 126

100 Hour 130

150 Hour 131

250 Hour 132

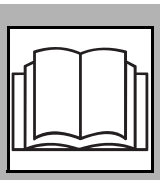
750 Hour 133

1000 Hour 134

2000 Hour 136

As Needed 136

Service Precautions



WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

NOTICES:

- Unless otherwise instructed, all service should be performed with engine off.
- Refer to engine manufacturer's manual for engine maintenance instructions.

Welding Precaution

NOTICE: Welding can damage electronics.

- Disconnect battery to prevent damage to battery. Do not turn off battery disconnect switch with engine running, or alternator and other electronic devices may be damaged.
- Connect welder ground clamp close to welding point and make sure no electronic components or bearings are in the ground path.

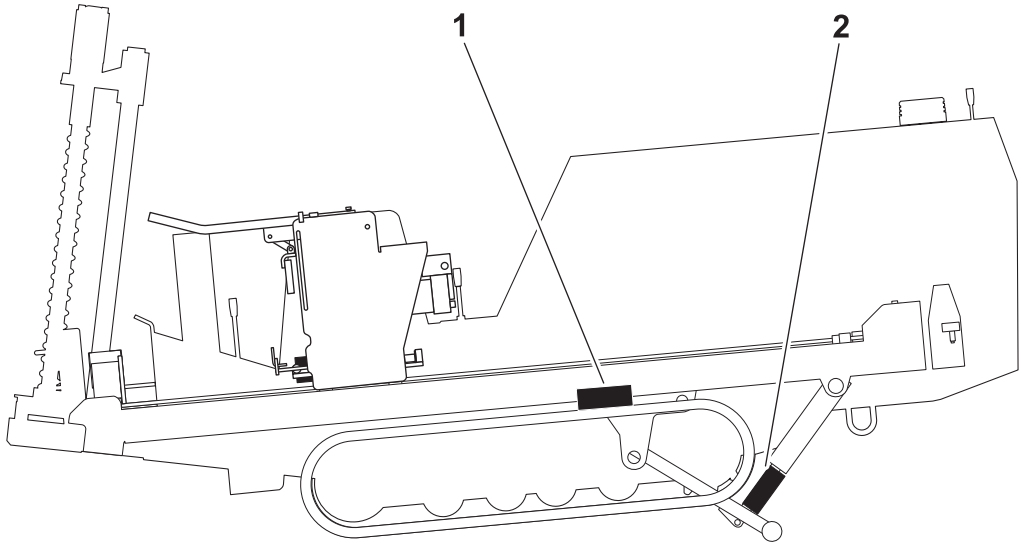
Washing Precaution

NOTICE: Water can damage electronics. When cleaning equipment, do not spray electrical components with water.

Working Under Drilling Unit

WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

Before working under area of drilling unit supported by a stabilizer, make sure drilling unit is parked on hard surface.



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1. Remove yellow cylinder lock from storage at rear of pipe box and place over extended cylinder rod (shown) with curved ends toward stabilizer shoe.
2. Raise stabilizer to lower unit until load is supported by cylinder lock.

Recommended Lubricants/Service Key

Item	Description
DEO	Diesel engine oil meeting API service classification CF-4 or E1-96 and SAE viscosity recommended by engine manufacturer (SAE 15W40)
EO	Engine oil (SAE 10W30)
MPG	Multipurpose grease meeting ASTM D217 and NLGI 5
MPL	Multipurpose gear oil meeting API service classification GL-5 (SAE 80W90)
DEAC	Diesel engine antifreeze/coolant meeting ASTM D5345 (prediluted) or D4985 (concentrate)
THF	Tractor hydraulic fluid, similar to Phillips 66 HG, Mobilfluid 423, Chevron Tractor Hydraulic Fluid, Texaco TDH Oil, or equivalent
TJC	Tool joint compound: Ditch Witch standard (p/n 259-858) or summer grade (p/n 256-031)
	Check level of fluid or lubricant
	Check condition
	Filter
	Change, replace, adjust, service or test

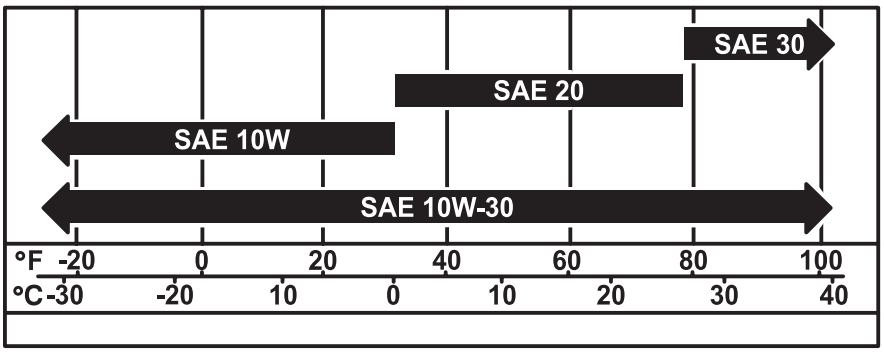
Proper lubrication and maintenance protects Ditch Witch equipment from damage and failure. Service intervals listed are for minimum requirements. In extreme conditions, service machine more frequently. Use only recommended lubricants. Fill to capacities listed in "Fluid Capacities" on page 143.

For more information on engine lubrication and maintenance, see your Kubota® engine manual.

NOTICE:

- Use only genuine Ditch Witch parts, filters, approved lubricants, TJC, and approved coolants to maintain warranty.
- Use the "Service Record" on page 149 to record all required service to your machine.

Engine Oil Temperature Chart



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Temperature range anticipated before next oil change

Approved Coolant

Any coolant is approved for use with this unit. However, it was filled with John Deere Cool-Gard coolant before shipment from factory. Add only Cool-Gard (p/n 255-006) or any fully-formulated, ethylene glycol based, low-silicate, heavy-duty diesel engine coolant meeting ASTM specification D5345 (prediluted) or D4985 (concentrate). Before using any other kind of coolant, completely flush radiator.

NOTICE: Do not mix heavy-duty diesel engine coolant and automotive-type coolant. This will lead coolant breakdown and engine damage.

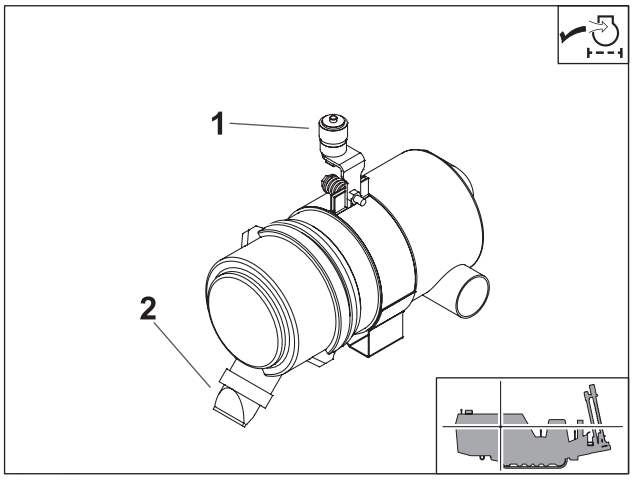
10 Hour

Location	Task	Notes
DRILLING UNIT	Check engine air filter service indicator	
	Check engine oil level	DEO
	Check hydraulic hoses	
	Check hydraulic fluid level	THF
	Check coolant level	DEAC
	Check drilling fluid pump oil level	

Drilling Unit

Check Engine Air Filter Service Indicator

Check air filter service indicator (1) every 10 hours and change filter as needed. See "Replace Air Filter" on page 132. Press evacuator (2) to expel trapped dust.



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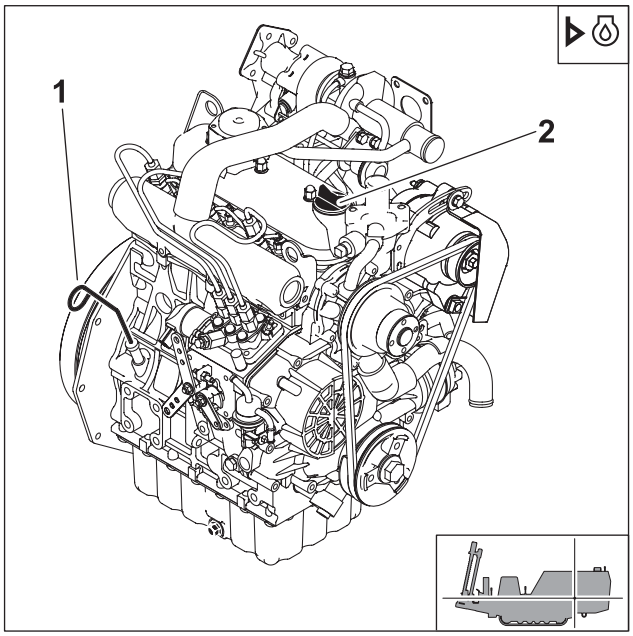
Check Engine Oil Level

While engine oil is warm, move carriage to front of drill frame and check oil level at dipstick (1) every 10 hours. Add DEO at fill (2) as necessary to keep oil level at highest line on dipstick.



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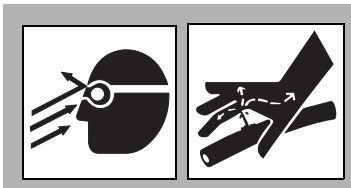
Check Hydraulic Hoses

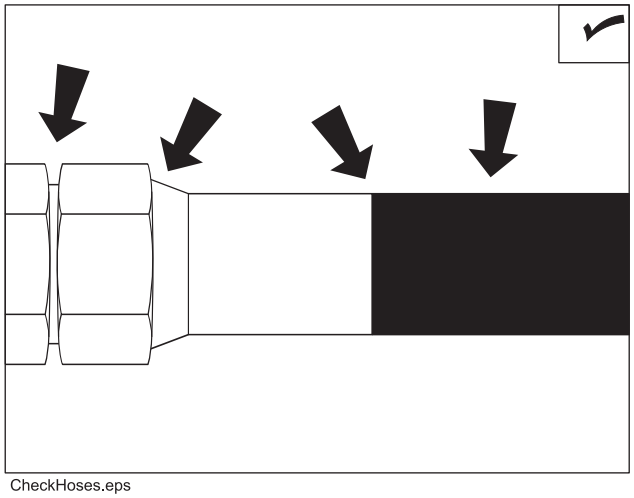


WARNING Pressurized fluid or air could pierce skin and cause injury or death. Stay away.

NOTICE: Escaping pressurized fluid can cause injury or pierce skin and poison.

- Before disconnecting a hydraulic line, turn engine off and operate all controls to relieve pressure. Lower, block, or support any raised component with a hoist. Cover connection with heavy cloth and loosen connector nut slightly to relieve residual pressure. Catch all fluid in a container.
- Before using system, check that all connections are tight and all lines are undamaged.
- Fluid leaks can be hard to detect. Use a piece of cardboard or wood, rather than hands, to search for leaks.
- Wear protective clothing, including gloves and eye protection.
- If you are injured, seek immediate medical attention from a doctor familiar with this type of injury.

Check hydraulic hoses for leaks every 10 hours.



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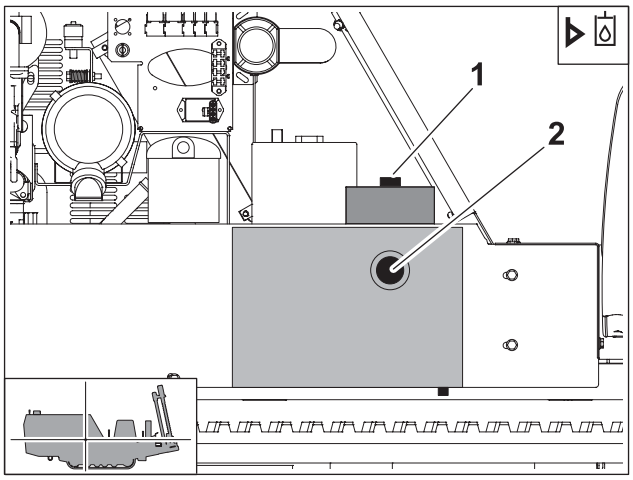
Check Hydraulic Fluid Level

Check hydraulic fluid level every 10 hours. Maintain fluid level at halfway point on sight glass (2) when engine is off and fluid is cool. Add THF at hydraulic fluid fill (1) as necessary.



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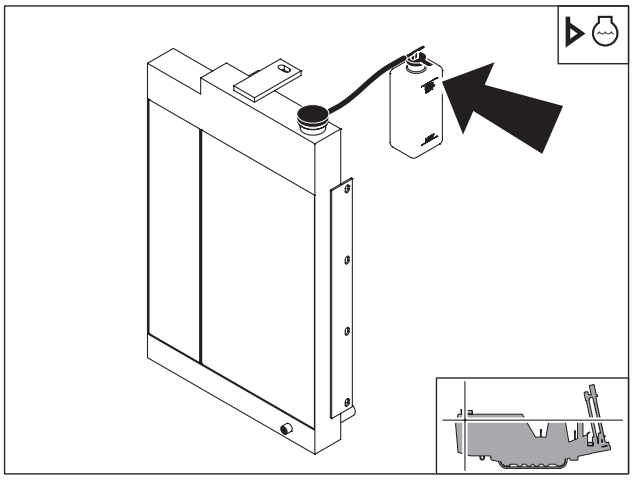
Check Coolant Level

Check coolant level every 10 hours. Add coolant as needed to maintain as shown on overflow bottle.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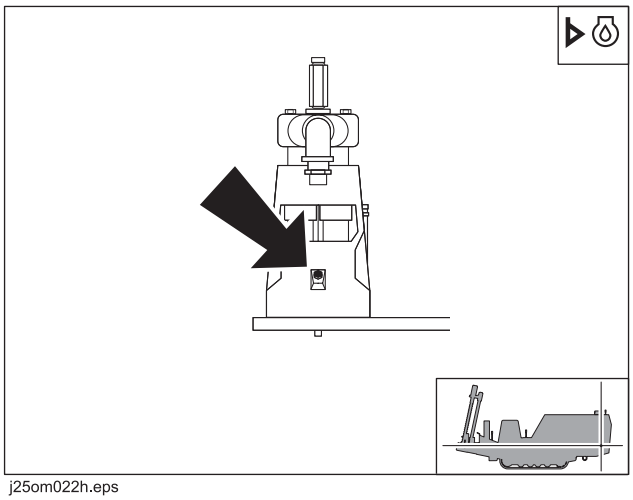
Check Drilling Fluid Pump Oil Level

Check drilling fluid pump oil level every 10 hours. Add EO as needed.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50 Hour

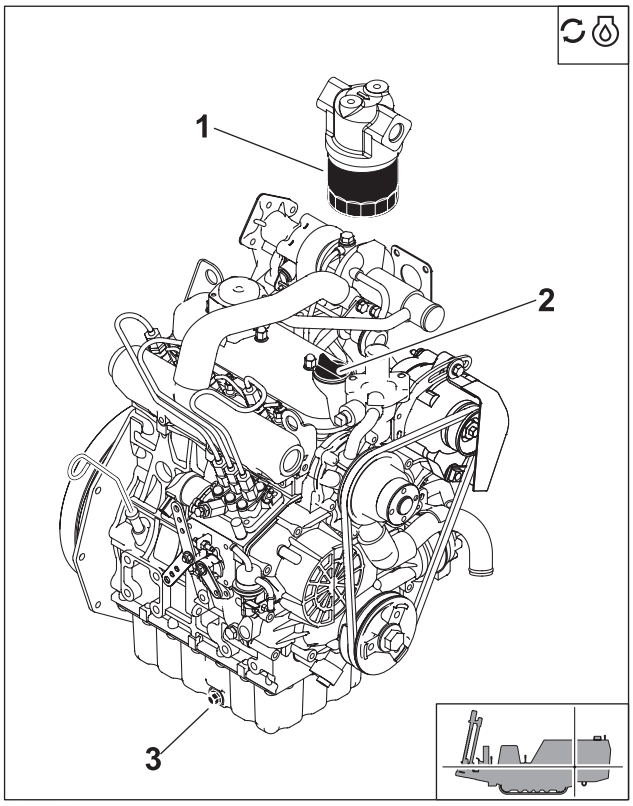
Location	Task	Notes
DRILLING UNIT	Change engine oil and filter	Initial service, DEO
	Change drilling fluid pump oil (initial)	EO
	Check radiator	
	Change hydraulic filter	Initial service
	Check rotation gearbox oil level	2 gearboxes, MPL
	Check battery	
	Change fuel filter	Initial service
	Check and adjust fan belt tension	

Drilling Unit

Change Engine Oil and Filter (Initial Service)

Change engine oil and filter after 50 hours. Drain oil (3), change filter (4), and add 4.2 qt (4 L) of DEO at fill (2).

IMPORTANT: Use oil specified in temperature chart found in "Recommended Lubricants/ Service Key" on page 120.



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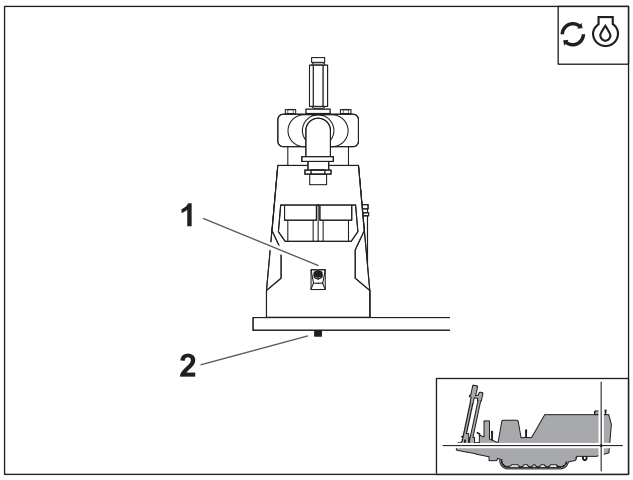
Change Drilling Fluid Pump Oil (Initial Service)

Change fluid pump oil after first 50 hours and every 750 hours thereafter. Drain at plug (2) and add EO at plug (1). Maintain fluid level at fill plug.



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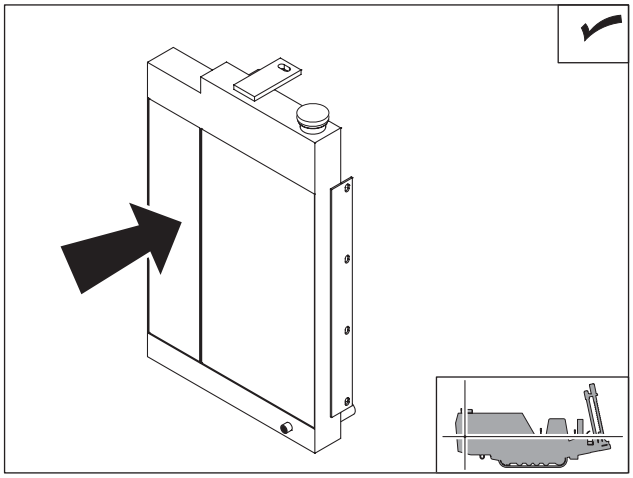
Check Radiator

Check radiator for dirt, grass, and other foreign matter every 50 hours. Check more often if operating in dusty or grassy conditions. Clean fins with compressed air or spray wash.

IMPORTANT: Be careful not to damage fins with high pressure air or water.



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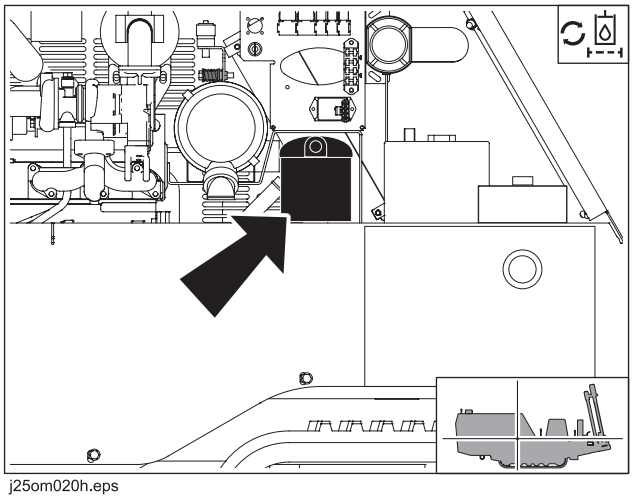
Change Hydraulic Filter (Initial Service)

Change hydraulic filter (shown) after first 50 hours.



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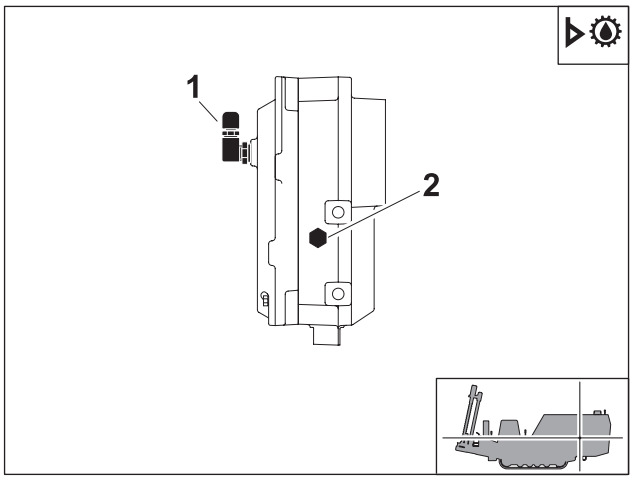
Check Rotation Gearbox Oil Level

Check rotation gearbox oil level every 50 hours. Oil should be visible at plug (2). Add MPL at plug (1) as needed.

IMPORTANT: Drill frame must be level for accurate reading.



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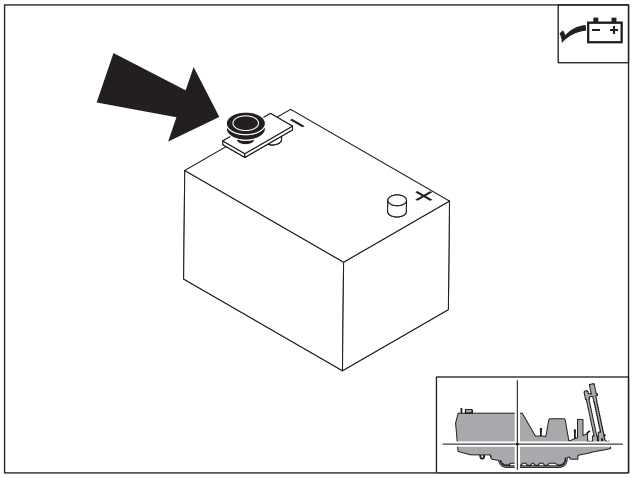
Check Battery

Keep batteries clean and free of corrosion. Apply coat of grease to cable clamps after cleaning.

In cold weather, battery loses some starting ability. Closely watch voltmeter for signs of battery discharge.

If battery will not hold charge, see your Ditch Witch dealer for replacement battery.

IMPORTANT: Use battery disconnect switch (shown) when servicing, welding, and during long-term storage.



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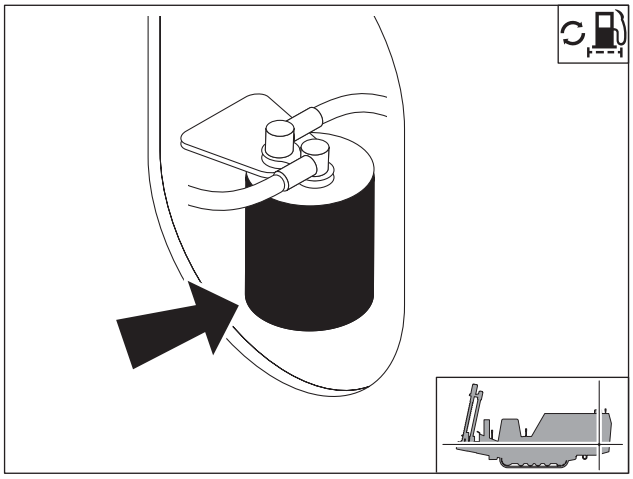
Change Fuel Filter (Initial)

Replace filter (shown) after 50 hours.



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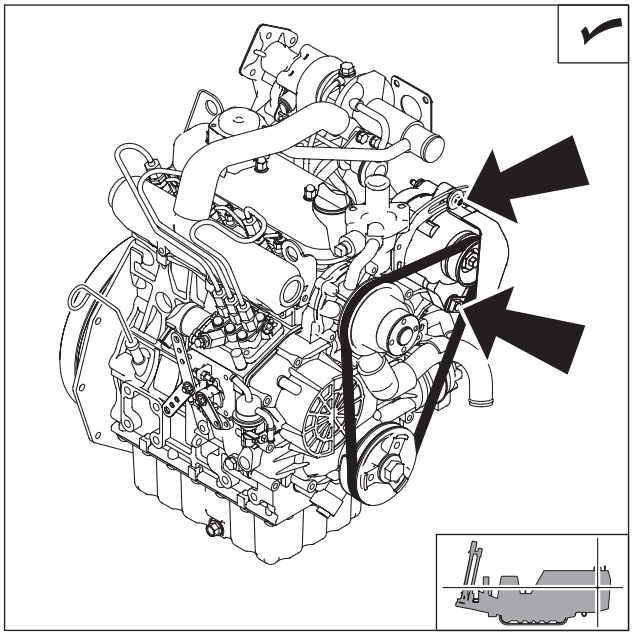
Check and Adjust Fan Belt Tension

Check belt tension every 50 hours. Belt is properly tensioned when it moves about 1/4-3/8" (7-9 mm) when pushed at the long span.

1. Loosen two alternator bolts (shown).
2. Adjust position as needed.
3. Tighten bolts.
4. Check tension.



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100 Hour

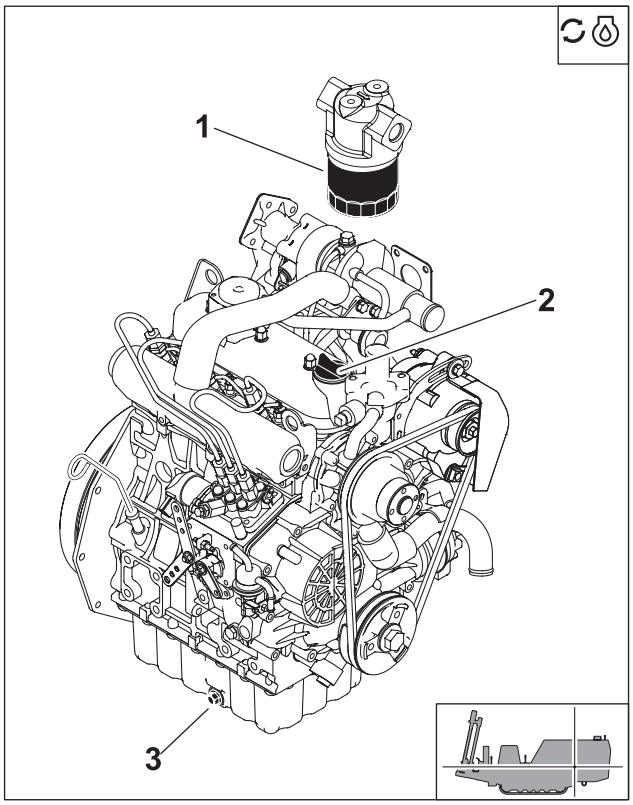
Location	Task	Notes
DRILLING UNIT	Change engine oil and filter	DEO
	Lube thrust chain	DEO

Drilling Unit

Change Engine Oil and Filter (Normal Service)

Change engine oil and filter every 100 hours for normal service. Drain oil (3), change filter (1), and add 4.2 qt (4 L) of DEO at fill (2).

IMPORTANT: Use oil specified in temperature chart found in "Recommended Lubricants/ Service Key" on page 120.



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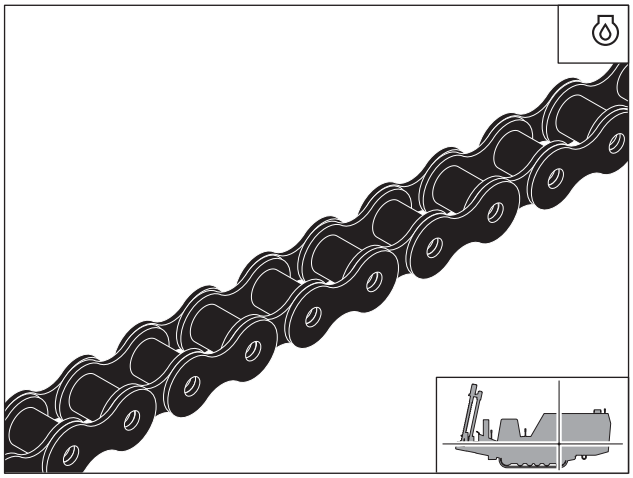
Lube Thrust Chain

Lube thrust chain with DEO every 100 hours.



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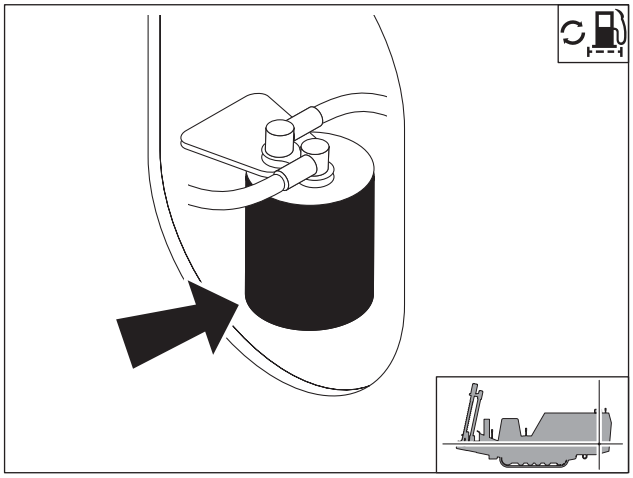
150 Hour

Change Fuel Filter

Change filter (shown) every 150 hours.



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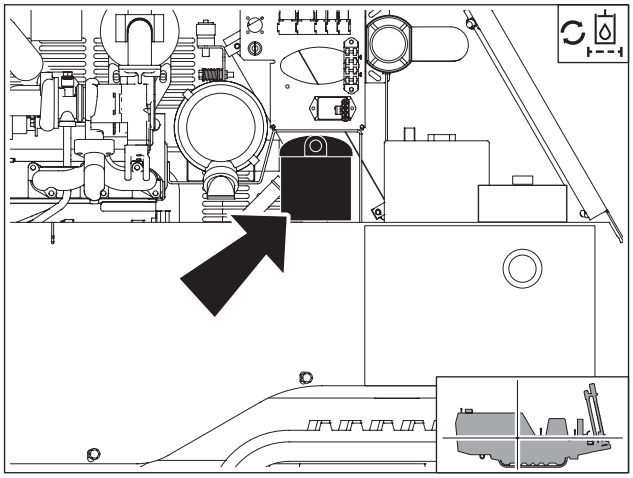
250 Hour

Location	Task	Notes
DRILLING UNIT	Change hydraulic fluid filter	
	Replace air filter	

Drilling Unit

Change Hydraulic Fluid Filter

Change filter (shown) every 250 hours. Change more often if indicated by filter indicator.



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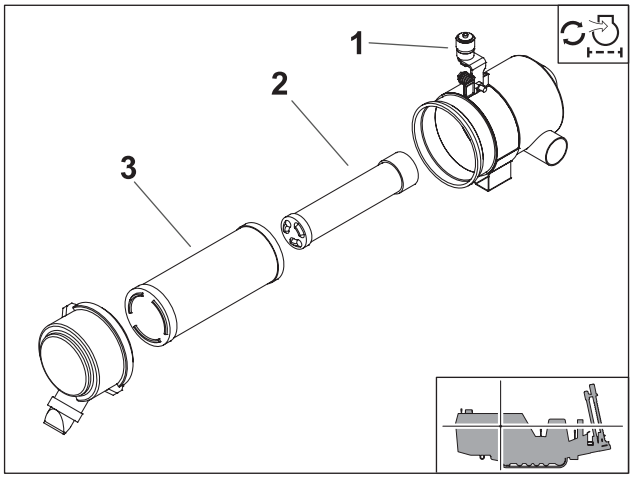
Replace Air Filter

Replace filter elements every 250 hours and when indicated by air filter service indicator.

1. Open air filter case.
2. Remove paper element (3) and safety element (2).
3. Wipe inside of case and wash end cup.
4. Install new elements in case.
5. Reset air filter service indicator (1).



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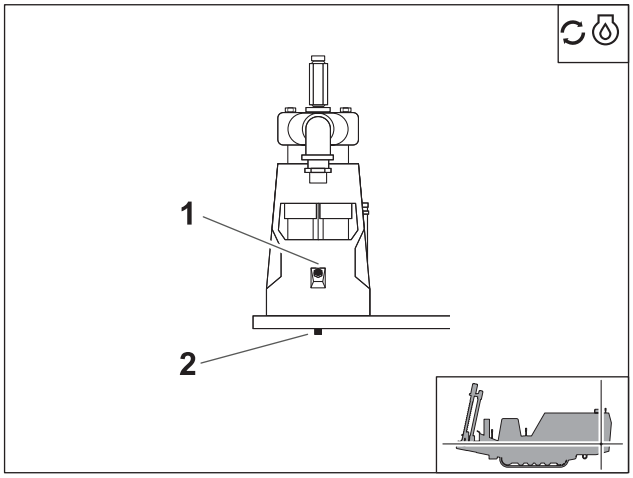
750 Hour

Change Drilling Fluid Pump Oil

Change fluid pump oil every 750 hours. Drain at plug (2) and add with EO oil at plug (1). Maintain fluid level at fill plug. Capacity for pump is 1 qt (0.9 L).



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1000 Hour

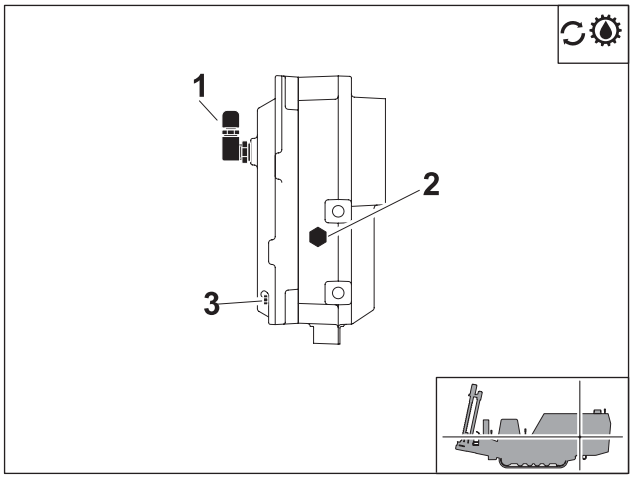
Location	Task	Notes
DRILLING UNIT	Change rotation gearbox oil	MPL
	Change hydraulic fluid and filter	THF

Drilling Unit

Change Rotation Gearbox Oil

Drain oil at gearbox oil drain (3) every 1000 hours. Replace drain plug. Add MPL at fill plug (1) until oil is visible at plug (2). Replace fill plug.

IMPORTANT: Drill frame must be level for accurate reading.



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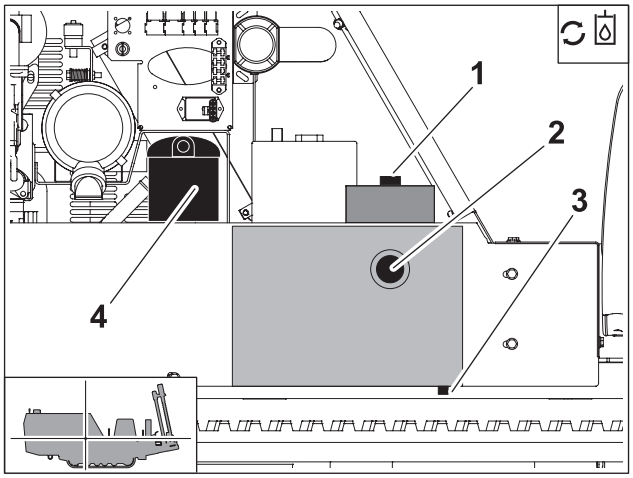
Change Hydraulic Fluid and Filter

Change hydraulic fluid and filter every 1000 hours. Drain hydraulic fluid (3), change filter (4), add THF at hydraulic fluid fill (1) and check level at sight glass (2).



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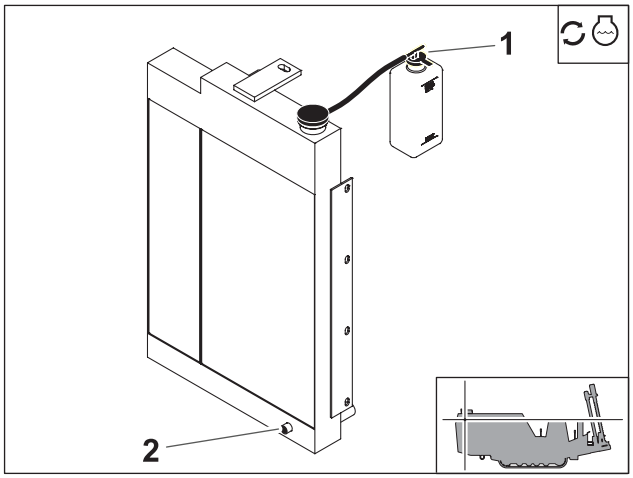
2000 Hour

Change Coolant

Drain (2) coolant and add DEAC at fill (1) every 2000 hours.



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As Needed

Location	Task	Notes
DRILLING UNIT	Change pipe lubricator TJC tube	TJC
	Check track tension and condition	
	Check thrust chain tension	
	Replace fan belt	
	Replace saver sub	
	Replace muffler	
	Check fluid pump check valve	
	Replace carriage slide bars	
	Replace fuses	

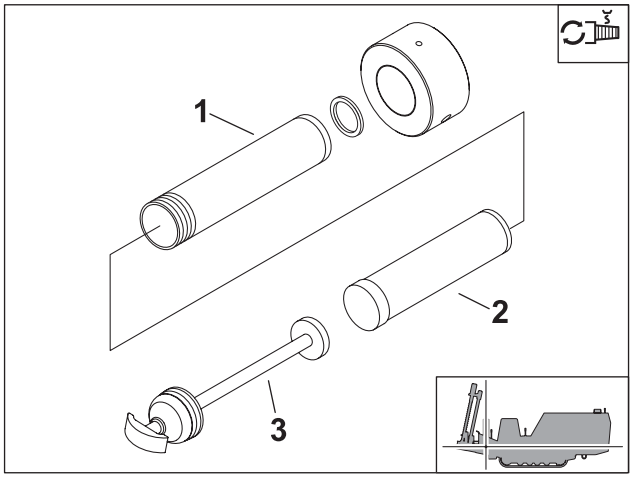
Drilling Unit

Change Lubricator TJC Tube

Check pipe lubricator TJC level and change tube as needed.

To change tube

1. Pull lock handle (3) back.
2. Unscrew cartridge (2).
3. Release handle and push tube (1) out.
4. Pull handle lock.
5. Remove caps and insert new tube of TJC.
6. Screw cartridge in.
7. Release handle.
8. Unscrew cartridge 2-3 turns.
9. Watch for grease to come out of weep hole.
10. Screw cartridge back in when grease comes out of hole..



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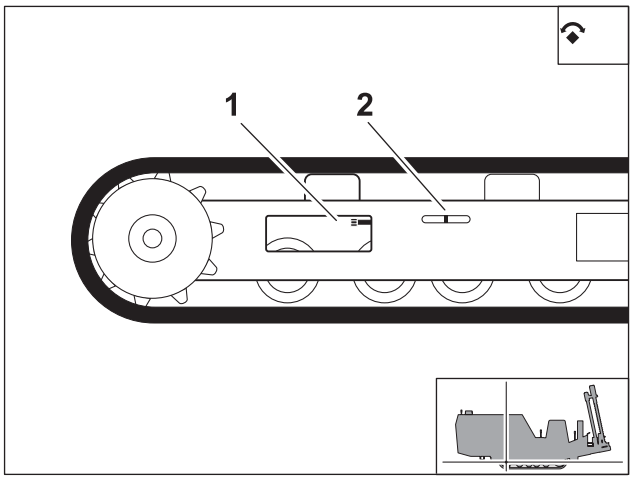
NOTICE: Use only genuine Ditch Witch tool joint compound to maintain warranty. See "Recommended Lubricants/Service Key" on page 120 for more information.

Check Track Tension and Condition

Check track tension and condition and adjust or replace as needed. See your Ditch Witch dealer for replacement parts.

To adjust, turn bolt (1) clockwise to tighten and counterclockwise to loosen. Track tension is correct when metal piece is exactly in the middle of cut out window (2).



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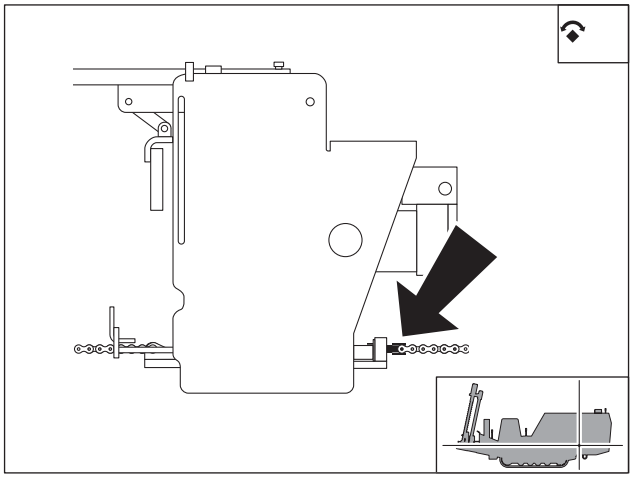
Adjust Thrust Chain Tension

Adjust thrust chain tension as needed.

1. Remove all pipe from pipe box.
2. Move carriage to front of frame.
3. Loosen jam nut (shown).
4. Turn adjuster bolt clockwise to tighten and counterclockwise to loosen chain. Chain is properly adjusted when bottom of chain is 3/8-1/2" (9-13 mm) above frame.
5. Tighten jam nut after adjusting.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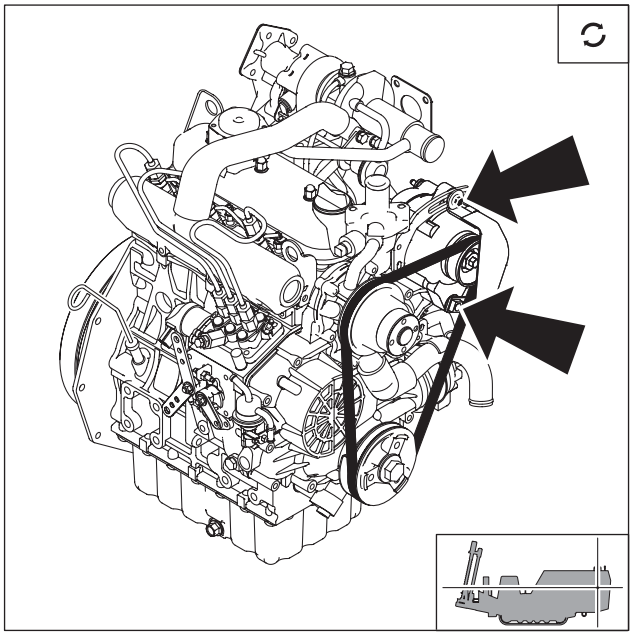
Replace Fan Belt

Replace belt as needed.

1. Loosen two alternator bolts (shown).
2. Adjust position to allow belt to slip off.
3. Install new belt.
4. Adjust position to tighten belt.
5. Tighten bolts.
6. Check tension.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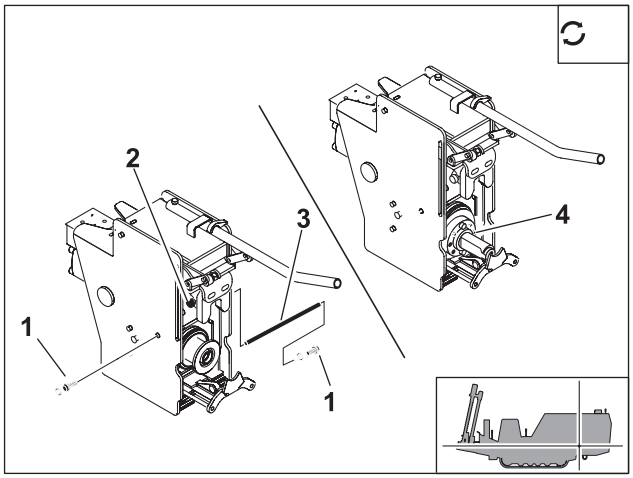
Replace Saver Sub

Check saver sub and replace as needed. See your Ditch Witch dealer for replacement parts.

To replace

IMPORTANT: Saver sub must mate up to every drill pipe. Check sub for thread wear. If saver sub threads are more worn than pipe threads, saver sub is damaging the drill pipe.

1. Remove bolt and washer (1) from both ends of shift lever pin (3).
2. Remove shift lever pin.
3. Remove bolt (2) that attaches back wrench collar to carriage frame.
4. Remove back wrench collar and six bolts (4) that attach saver sub to carriage.
5. Replace o-ring if necessary.
6. Install new saver sub in reverse order and tighten six bolts to 15 ft•lb (19 N•m)..



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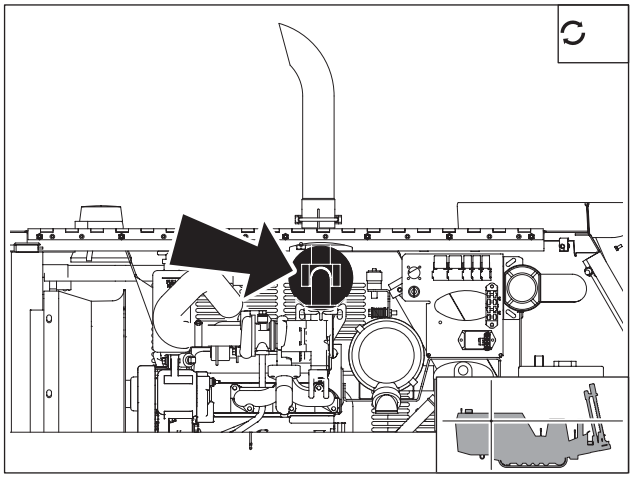
Replace Muffler

Replace muffler (shown) as needed.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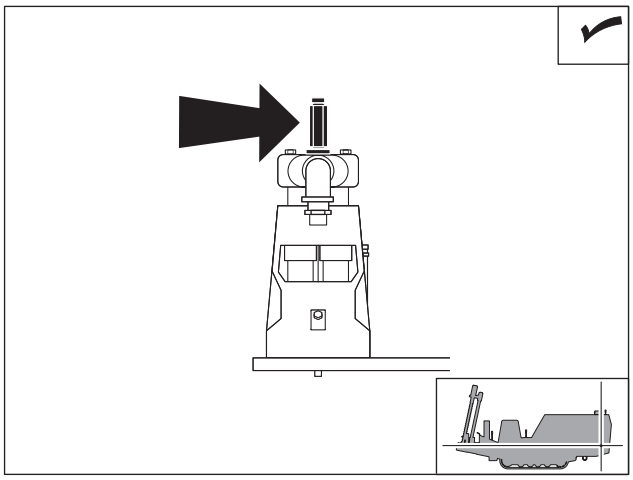
Check Drilling Fluid Pump Check Valve

Check fluid pump check valve (shown) o-ring for wear and replace as needed.



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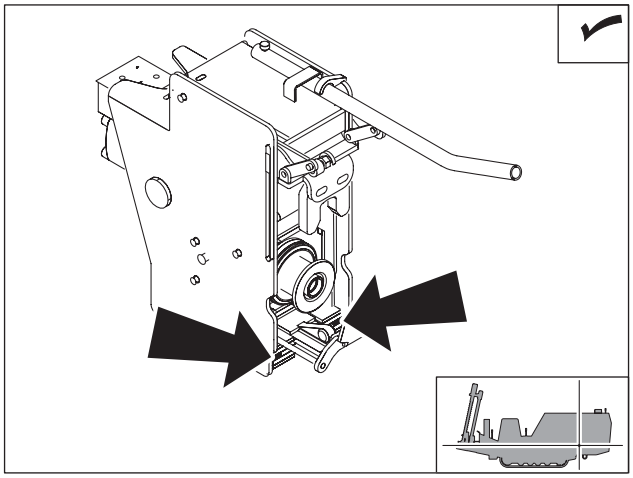
Check Carriage Slide Bars

Check slide bars (shown) for wear and replace as needed.



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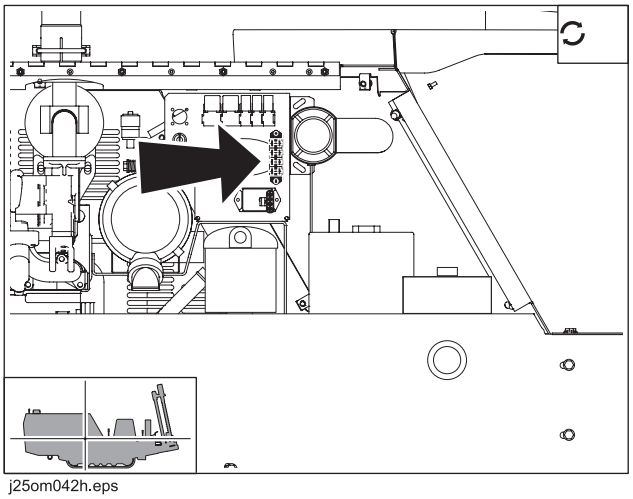
Replace Fuses

Change fuses (shown) as needed. Refer to decal inside panels to identify fuses.



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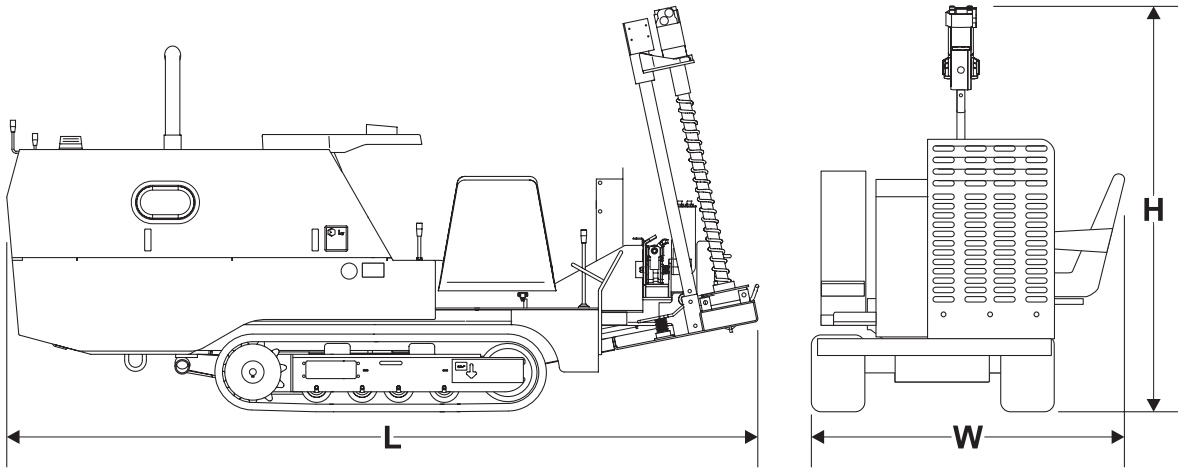
Specifications



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Dimensions	U.S.	Metric
L, overall machine length	117 in	3 m
W, overall machine width	35.5 in	900 mm
H, overall machine height	66.5 in	1.7 m
Operating weight w/150'/45.7 m of drill pipe, anchoring system and anchor	2980 lb	1352 kg

UFE Pipe	U.S.	Metric
Length	59.1 in	1.5 m
Joint diameter	1.75 in	44.5 mm
Tubing diameter	1.1 in	28 mm
Minimum bend radius	70 ft	21.3 m
Weight	16 lb	7.3 kg

Operational		**U.S.**	**Metric**
Maximum spindle speed		195 rpm	195 rpm
Spindle torque, makeup		500 ft•lb	678 N•m
Spindle torque, breakout		600 ft•lb	813 N•m
Thrust force		4500 lb	20 kN
Pullback force		5000 lb	22.2 kN
Carriage travel speed		142 fpm	43.3 m/min
Minimum bore diameter		2.5 in	89 mm
Backream diameter (soil dependent)		variable	variable
Ground travel speed			
	forward	0-1.5 mph	0-2.5 km/h
	reverse	0-1.5 mph	0-2.5 km/h
Ground bearing pressure		6.5 psi	.46 kg/cm2

Power	**U.S.**	**Metric**
Engine: Kubota D1105-T, diesel (Use low sulfur or ultra low sulfur fuel only.)		
Number of cylinders	3	
Displacement	68.5 in^3	1.12 L
Bore	3.07 in	78 mm
Stroke	3.09 in	78.4 mm
Manufacturer's gross power rating (per SAE J1955)	32.8 hp	24.5 kW
Estimated net power rating (per SAE 1348)	31.5 hp	23.5 kW
Rated engine speed	3000 rpm	3000 rpm
Maximum tilt angle, fore and aft	30°	30°
Maximum tilt angle, side to side	30°	30°

* Exceeding these operating angles will cause engine damage. This DOES NOT imply that the machine is stable to maximum angle of safe engine operation.

Drilling Fluid System (Onboard)	U.S.	Metric
Maximum drilling fluid flow	0-5 gpm	0-18.9 L/min
Maximum drilling fluid pressure	500 psi	34.5 bar

Fluid Capacities	U.S.	Metric
Fuel tank	10 gal	38 L
Hydraulic reservoir	8 gal	30 L
Engine oil, including filter	4.2 qt	4 L

Battery
SAE reserve capacity rating 81 min, 12V, negative ground, SAE cold crank rating @ 0°F (-18°C), 525 amps.

Noise Levels
Operator < 86 dBA sound pressure per ISO 6394 Exterior < 104 dBA sound power per ISO 6393

Specifications are called out according to SAE recommended practices where indicated. Specifications are general and subject to change without notice. If exact measurements are required, equipment should be weighed and measured. Due to selected options, delivered equipment may not necessarily match that shown.

Support

Procedure

Notify your dealer immediately of any malfunction or failure of Ditch Witch equipment.

Always give model, serial number, and approximate date of your equipment purchase. This information should be recorded and placed on file by the owner at the time of purchase.

Return damaged parts to dealer for inspection and warranty consideration if in warranty time frame.

Order genuine Ditch Witch replacement or repair parts from your authorized Ditch Witch dealer. Use of another manufacturer's parts may void warranty consideration.

Resources

Publications

Contact your Ditch Witch dealer for publications and videos covering safety, operation, service, and repair of your equipment.

Ditch Witch Training

For information about on-site, individualized training, contact your Ditch Witch dealer.

Warranty

Ditch Witch Equipment and Replacement Parts Limited Warranty Policy

Subject to the limitation and exclusions herein, free replacement parts will be provided at any authorized Ditch Witch dealership for any Ditch Witch equipment or parts manufactured by The Charles Machine Works, Inc. (CMW) that fail due to a defect in material or workmanship within one (1) year of first commercial use (Exception: 2 years for all SK5 attachments). Free labor will be provided at any authorized Ditch Witch dealership for installation of parts under this warranty during the first year following "initial commercial" use of the serial-numbered Ditch Witch equipment on which it is installed. The customer is responsible for transporting their equipment to an authorized Ditch Witch dealership for all warranty work.

Exclusions from Product Warranty

- All incidental or consequential damages.
- All defects, damages, or injuries caused by misuse, abuse, improper installation, alteration, neglect, or uses other than those for which products were intended.
- All defects, damages, or injuries caused by improper training, operation, or servicing of products in a manner inconsistent with manufacturer's recommendations.
- All engines and engine accessories (these are covered by original manufacturer's warranty).
- Tires, belts, and other parts which may be subject to another manufacturer's warranty (such warranty will be available to purchaser).
- ALL IMPLIED WARRANTIES NOT EXPRESSLY STATED HEREIN, INCLUDING ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY.

IF THE PRODUCTS ARE PURCHASED FOR COMMERCIAL PURPOSES, AS DEFINED BY THE UNIFORM COMMERCIAL CODE, THEN THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF AND THERE ARE NO IMPLIED WARRANTIES OF ANY KIND WHICH EXTEND TO A COMMERCIAL BUYER. ALL OTHER PROVISIONS OF THIS LIMITED WARRANTY APPLY INCLUDING THE DUTIES IMPOSED.

Ditch Witch products have been tested to deliver acceptable performance in most conditions. This does not imply they will deliver acceptable performance in all conditions. Therefore, to assure suitability, products should be operated under anticipated working conditions prior to purchase.

Defects will be determined by an inspection within thirty (30) days of the date of failure of the product or part by CMW or its authorized dealer. CMW will provide the location of its inspection facilities or its nearest authorized dealer upon inquiry. CMW reserves the right to supply remanufactured replacements parts under this warranty as it deems appropriate.

Extended warranties are available upon request from your local Ditch Witch dealer or CMW.

Some states do not allow exclusion or limitation of incidental or consequential damages, so above limitation of exclusion may not apply. Further, some states do not allow exclusion of or limitation of how long an implied warranty lasts, so the above limitation may not apply. This limited warranty gives product owner specific legal rights and the product owner may also have other rights which vary from state to state.

For information regarding this limited warranty, contact CMW's Product Support department, P.O. Box 66, Perry, OK 73077-0066, or contact your local Ditch Witch dealer.

First version: 1/91; Latest version: 7/05

A Note To Ditch Witch Equipment Owners:

If your equipment was purchased through a Ditch Witch dealer, there is no need to read further.

However, if you purchased from any other source, please fill out the form on the reverse side and return it to us.

This will enable you to receive updates on this equipment as well as information on new products of interest.

Thanks for using Ditch Witch equipment.

(Please Fold Along This Line And Seal At Bottom With Tape)

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO 23 PERRY OKLAHOMA

POSTAGE WILL BE PAID BY

The Charles Machine Works, Inc.
P.O. Box 66
Perry, Oklahoma 73077-9989

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FIRST CLASS PERMIT NO 23 PERRY OKLAHOMA

POSTAGE WILL BE PAID BY

The Charles Machine Works, Inc.
P.O. Box 66
Perry, Oklahoma 73077-9989

Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name

Attention

Street Address or P.O. Box

City County

State Zip Nation

( )

Phone Number With Area Code

Model Serial Number

Attachments/Accessories Serial Numbers

Attachments/Accessories Serial Numbers

Attachments/Accessories Serial Numbers

Name of Ditch Witch Dealership

Your Signature

Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name

Attention

Street Address or P.O. Box

City County

State Zip Nation

( )

Phone Number With Area Code

Model Serial Number

Attachments/Accessories Serial Numbers

Attachments/Accessories Serial Numbers

Attachments/Accessories Serial Numbers

Name of Ditch Witch Dealership

Your Signature

Service Record

Service Performed	Date	Hours

Service Performed	Date	Hours